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Data handbook

Electronic components and materials

Electron tubes

Book T13 1986

Image intensifiers

Infrared detectors

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IMAGE INTENSIFIERS AND INFRARED DETECTORS

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Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of four series of handbooks:

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The contents of each series are listed on pages iv to viii.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

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T2a **Transmitting tubes for communications, glass types**

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T3 **Klystrons**

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T12 **Vidicon and Newvicon camera tubes**

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S4b **High-voltage and switching power transistors**

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S6 **R.F. power transistors and modules**

S7 **Surface mounted semiconductors**

S8 **Devices for optoelectronics**
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S9 **Power MOS transistors**

S10 **Wideband transistors and wideband hybrid IC modules**

S11 **Microwave transistors**

S12 **Surface acoustic wave devices**

S13 **Semiconductor sensors**

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The purple series of data handbooks comprises:

EXISTING SERIES		Superseded by:
IC1	**Bipolar ICs for radio and audio equipment**	IC01N
IC2	**Bipolar ICs for video equipment**	IC02Na and IC02Nb
IC3	**ICs for digital systems in radio, audio and video equipment**	IC01N, IC02Na and IC02Nb
IC4	**Digital integrated circuits** CMOS HE4000B family	
IC5	**Digital integrated circuits – ECL** ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs	IC08N
IC6	**Professional analogue integrated circuits**	
IC7	**Signetics bipolar memories**	
IC8	**Signetics analogue circuits**	IC11N
IC9	**Signetics TTL logic**	IC09N and IC15N
IC10	**Signetics Integrated Fuse Logic (IFL)**	IC13N
IC11	**Microprocessors, microcomputers and peripheral circuitry**	IC14N

NEW SERIES

IC01N	**Radio, audio and associated systems** Bipolar, MOS	(published 1985)
IC02Na	**Video and associated systems** Bipolar, MOS Types MAB8031AH to TDA1524A	(published 1985)
IC02Nb	**Video and associated systems** Bipolar, MOS Types TDA2501 to TEA1002	(published 1985)
IC03N	**Integrated circuits for telephony**	(published 1985)
IC04N	**HE4000B logic family** CMOS	
IC05N	**HE4000B logic family — uncased ICs** CMOS	(published 1984)
IC06N	**High-speed CMOS; PC54/74HC/HCT/HCU** Logic family	(published 1985)
Supplement to IC06N	**High-speed CMOS; PC74HC/HCT/HCU** Logic family	(published 1985)
IC07N	**High-speed CMOS; PC54/74HC/HCT/HCU — uncased ICs** Logic family	
IC08N	**ECL 10K and 100K logic families**	(published 1984)
IC09N	**TTL logic series**	(published 1984)
IC10N	**Memories** MOS, TTL, ECL	
IC11N	**Linear LSI**	(published 1985)
IC12N	**Semi-custom gate arrays & cell libraries** ISL, ECL, CMOS	
IC13N	**Semi-custom** Integrated Fuse Logic	(published 1985)
IC14N	**Microprocessors, microcontrollers & peripherals** Bipolar, MOS	(published 1985)
IC15N	**FAST TTL logic series**	(published 1984)

Note

Books available in the new series are shown with their date of publication.

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks comprises:

C1 **Programmable controller modules**
PLC modules, PC20 modules

C2 **Television tuners, coaxial aerial input assemblies, surface acoustic wave filters**

C3 **Loudspeakers**

C4 **Ferroxcube potcores, square cores and cross cores**

C5 **Ferroxcube for power, audio/video and accelerators**

C6 **Synchronous motors and gearboxes**

C7 **Variable capacitors**

C8 **Variable mains transformers**

C9 **Piezoelectric quartz devices**

C10 **Connectors**

C11 **Non-linear resistors**

C12 **Potentiometers, encoders and switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Ceramic capacitors**

C16 **Permanent magnet materials**

C17 **Stepping motors and associated electronics**

C18 **Direct current motors**

C19 **Piezoelectric ceramics**

C20 **Wire-wound components for TVs and monitors**

C21* **Assemblies for industrial use**
HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices

C22 **Film capacitors**

* To be issued shortly

IMAGE INTENSIFIERS

GENERAL INTRODUCTION

1. INTRODUCTION

Image Intensifiers are electron-optical devices in which the image of a scene focused onto a photocathode is intensified electronically and displayed on a luminescent screen.

Most current image intensifiers are of the "second generation" type comprising a multi-alkali photocathode, an electrostatic focusing system, a microchannel plate (MCP) as amplifying element and a luminescent screen, positioned immediately behind the MCP. In most cases a high-voltage power supply, operating from low-voltage batteries, is included in the encapsulation.

Second generation image intensifiers can be conveniently classified according to the focusing method used and by whether or not the output image is inverted. In some intensifiers the electrons emitted from the photocathode are focused onto the MCP by an electron lens which inverts the image. In others "proximity focusing" is used throughout, the MCP being very close to the photocathode. In this "double proximity" or "wafer" configuration the image is not inverted unless a special fibre-optic inverter ("twister") is used as the output window.

1.1 The photocathode

In our image intensifiers an S25 multi-alkali photocathode is laid on the inner surface of the – usually fibre-optic – input window. The most important properties of the photocathode are its spectral response and sensitivity. Sensitivity is expressed in two ways, luminous sensitivity in μA/lm (white light) and radiant sensitivity in mA/W (at a given wavelength). Sensitivity is measured with a tungsten lamp at a colour temperature of 2856 ± 50 K. Filters are used to obtain the radiant sensitivity at wavelengths of 800 nm and 850 nm. Passive night vision applications require photocathodes with high luminous and radiant sensitivities, especially in the near infrared. The S25 is optimum in these respects.

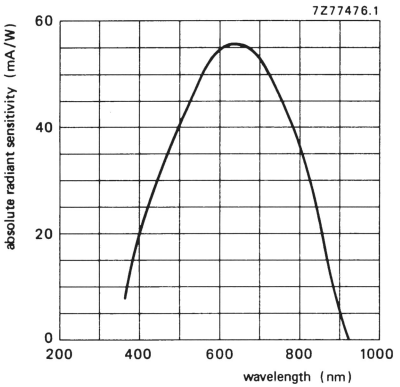


Fig. 1 Typical S25 spectral response curve.

1.2 The electrostatic focusing system

All our image intensifiers are electrostatistically focused, either by an electron lens or by the proximity method. The design of the electron optics determines such parameters as magnification, distortion, resolution, image alignment and in the case of inverter tubes with a built-in iron trap, the operational life.

1.3 The microchannel plate

In all the image intensifiers mentioned in this publication the image is intensified by a microchannel plate, which considerably reduces size and weight compared with first generation intensifiers having the same gain (image intensification). Other advantages of the use of a MCP are point highlight saturation, and – in combination with the power supply – automatic gain control (AGC), flash protection and automatic brightness control (ABC).

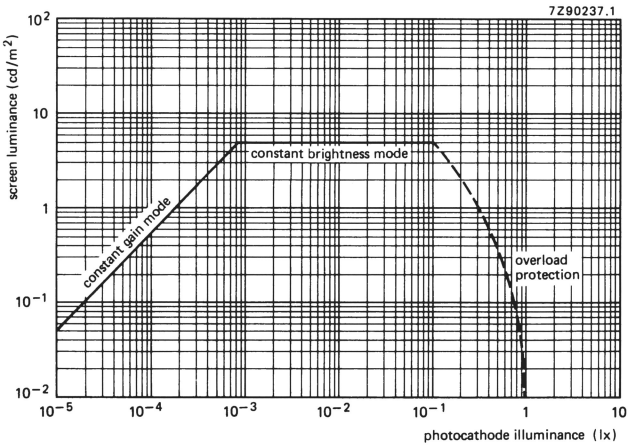


Fig. 2 Example of screen luminance as a function of photocathode illuminance.

1.4 The luminescent screen

Since the screen of an image intensifier is usually viewed directly, our standard green phosphor is of the P20 type to which the eye is particularly sensitive.

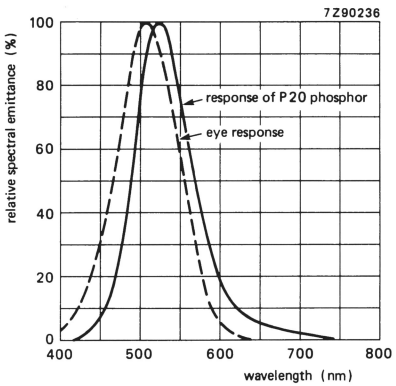


Fig. 3 Typical spectral emittance of P20 phosphor and spectral response of dark-adapted eye.

The decay time of the output phosphor of an image intensifier is the time taken (after the excitation due to the incident electron beam is removed) for the screen luminance to fall to 37% (e^{-1}) of the initial peak value. For MCP image intensifiers with the standard P20 type phosphor this is approximately 0,5 ms. For image intensifiers with other types of phosphor this may be in the 0,2 to 1 ms range. For special applications alternative phosphors with different characteristics may be available.

2 CHARACTERISTICS

2.1 Gain (or luminance gain)

The gain of an image intensifier is related to the screen luminance L_o (cd/m^2) and the illuminance E_i (lx) of the photocathode by:

$$\text{gain} = \frac{\pi L_o}{E_i}.$$

The screen luminance is measured over a diameter of ϕ_G in a direction normal to the screen, using an eye-corrected photometer having an acceptance angle of less than 10°. The photocathode is uniformly illuminated over a stated area by a tungsten lamp operating at a colour temperature of 2856 ± 50 K. The data for each particular image intensifier type states the applicable values of E_i and ϕ_G. Gain is dimensionless.

2.2 Mean screen luminance

This is the mean luminous intensity (cd) of the screen over a stated area (m^2). This characteristic is given only for intensifiers with an integral power supply because it depends on the properties of the power supply. Automatic brightness control (ABC) is a means of limiting the screen brightness at high levels of photocathode illuminance. Where appropriate, the ABC characteristics are given in the data.

2.3 Magnification and distortion

The magnification of an image intensifier is normally measured at two diameters. Centre magnification is determined by measuring the diameter ϕ_s of the image on the screen of a small circle of diameter ϕ_d projected on the centre of the photocathode. The centre magnification M_d is then defined as ϕ_s/ϕ_d.

Similarly the edge magnification is obtained by measuring the diameter ϕ_S of the image on the screen of a larger circle of diameter ϕ_D projected on the photocathode, and the edge magnification M_D is defined as ϕ_S/ϕ_D.

Because the small diameter ϕ_s is difficult to measure accurately, errors may occur in the determination of M_d unless great care is taken.

In intensifiers focused by an electron lens, magnification sometimes varies with the distance from the centre of the screen, causing a small amount of distortion in the image. This kind of distortion cannot occur in proximity focused intensifiers, but a very small amount of optical distortion may be introduced by the output fibre optics (twister) for image inversions, if used.

Distortion in the data sheets for individual types refers to percentage distortion, which is calculated as

$$\left(\frac{M_D}{M_d} - 1 \right) \times 100.$$

2.4 Limiting resolution and modulation transfer factors

Limiting resolution and modulation transfer factors indicate the degradation in image introduced by an imaging device. Limiting resolution is measured using a standard resolution test chart. For the limiting resolution figures given in the data, a bar pattern with a mark-to-space ratio of 1 : 1 and a contrast approaching 100% is used. The figures relate to the photocathode. The resolution pattern on the photocathode and the screen is examined with a microscope of at least 5x to 10x magnification. Two figures are normally given (in line pairs per mm, i.e. lp/mm); the centre resolution and the resolution at a distance from the centre $\phi_E/2$. The latter is known as the edge resolution.

The practice of specifying image quality in terms of limiting resolution is borrowed from photography. A better characteristic for optical systems (intensifiers may be considered as optical systems) is the modulation transfer function (MTF). When a bar pattern with sinusoidally varying intensity is projected onto the input of an optical system which satisfies the transfer conditions (light output linearly related to light input and where the imaging properties do not vary from point to point), the image at the output will also be a sinusoidal bar pattern but with lower contrast (modulation). Then a Fourier analysis will yield the MTF as the relation between the contrast at the input to that at the output over a range of spatial frequencies. The relation at any one frequency (line pairs/mm or cycles/mm) is the modulation transfer factor. It may be referred to either the input (photocathode) or the output (screen) plane and is normalised to 100% at zero lines/mm or zero cycles/mm. An example of an MTF curve is given in Fig. 4.

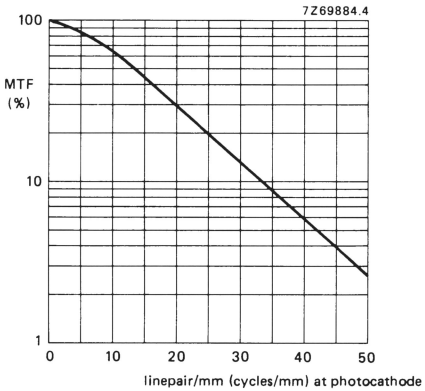


Fig. 4 Typical modulation transfer function curve.

Veiling glare is the ratio (%) between the luminance of the dark part of the screen with a partially illuminated input and the luminance of the light part of the screen with a (partially) illuminated input.

2.5 Signal-to-noise ratio

The signal-to-noise ratio of the image arriving at the input window deteriorates as it passes through the intensifier. Deterioration occurs at the photocathode (and is related to the photocathode quantum efficiency), at the input "open area " of the MCP and in the channels of the MCP. Signal-to-noise ratio is determined by measuring the signal-to-noise ratio of the image on the screen of a small, uniformly illuminated area on the photocathode.

2.6 Equivalent background illumination (EBI)

With the supply voltage applied and no input illumination incident on the photocathode, for various reasons the screen will have a finite background brightness. The EBI is the input illuminance required to give an increase in screen brightness equivalent to this background brightness.

2.7 Brightness uniformity (or screen luminance ratio)

The luminance from the output window may vary somewhat over the screen, but this does not detract from the image quality, provided that there is no sharp demarcation between lighter and darker areas. For some types a brightness uniformity value is given. This is the ratio of the maximum to the minimum value of the luminance of small areas over the useful screen area, when the photocathode is uniformly illuminated by a white light source.

2.8 Picture quality

In all image intensifiers some minor blemishes may occur that do not affect normal usage. A blemish is defined as a dark or bright area differing in contrast by more than 30% with respect to the immediate surrounding area. The picture quality of all intensifiers is assessed using a magnifier of between 5x and 10x magnification. There is a difference in the appearance between an intensified image viewed directly through a magnifier and that viewed through a TV system.

2.9 Image alignment

The geometric and optical axes of the intensifier may not coincide. Image alignment is a measure of this. It is the distance on the screen between the geometric axis and the image of a point at the geometric centre of the photocathode.

2.10 Recovery time

The recovery time is the time taken for a useful image to be restored on the screen after a rapid change in photocathode illuminance. The photocathode is subjected to an illumination pulse and the time between the end of the pulse and recovery to a specified steady-state output is measured.

3 RATINGS, ETC.

3.1 Supply voltage

The supply voltage required to operate an image intensifier is given in the data. Under no circumstances should the Absolute Maximum Rating be exceeded. Precautions should be taken to protect the device against switching transients, e.g. by a 10 μF capacitor across the supply terminals. An intensifier with an encapsulated power supply will not function but will not be damaged if the supply voltage is reversed for up to one minute. The length of the connecting leads to the intensifier should be kept to a minimum.

3.2 Maximum photocathode illuminance

The figure given in the data refers to a uniform continuous illuminance. All intensifiers will tolerate intermittent bursts of cathode illuminance that are much higher than the rated maximum value. However, prolonged exposure to any source of bright illumination will damage the intensifier. Some intensifiers incorporate automatic control of brightness or gain (ABC or AGC). These reduce the screen luminance but do not necessarily reduce the photocathode current. Whenever possible, the photocathode illuminance should comply with the recommended operating conditions where given in the data.

3.3 Storage and handling

Intensifiers should be stored in a desiccated, airtight container in a room where the temperature is maintained between specified limits. The devices must be handled with care. In particular, the case must not be compressed and the fibre optic windows should be protected from damage by dust, grit, etc. The protective plastic end-caps should not be removed until the intensifier is about to be mounted in the equipment (see also the Warning in section 8).

3.4 Mounting

Intensifiers may normally be oriented in any direction when mounted in equipment. Should a particular type have an optimum mounting orientation this is mentioned in the data. The intensifier should be mounted in equipment in such a way that any axial forces are taken by the bearing surfaces and not by the input or output windows. Care should be taken to ensure that no conductive equipment component is mounted so close to the input or output window (i.e. within a few millimetres) that flash-over can occur. See also sections 5 and 8.

4 OUTLINE DRAWING

The outline drawing given in the data shows only the major dimensions of the device. The supplier should be consulted when equipment is being designed.

5 HIGH POTENTIALS

Image intensifiers operate at high potentials, hence precautions must be taken to ensure that, when the supply voltage is connected or when residual high potentials may exist on the connectors or faceplates of the intensifier, the atmosphere surrounding the intensifier is dry throughout the operating temperature range. Some microchannel plate image intensifiers remain at a potential of several kV for up to one hour after switching off. Irreparable damage may occur if the input or output windows are connected to the supply terminal of the intensifier. The screen and cathode windows of microchannel plate image intensifiers are at opposite potentials of approximately 6 kV with respect to the input terminals. As all image intensifiers are very sensitive to corona discharge, it is recommended that suitable anti-corona measures be taken.

6 SAFETY

Image intensifiers with integral power supplies offer no risk during normal operation in night vision equipment. The power supplies in encapsulated intensifiers operate at frequencies of between 1 and 40 kHz. The noise produced is unlikely to be detrimental to health.

After operation, an intensifier may retain a charge of several kV for a number of hours. Fibre-optic or glass plates, or any metal component of the intensifier, must not be touched by the operator or allowed to come into contact with any conductive material. Failure to observe these precautions may cause irreparable damage to the intensifier and be hazardous to the operator. If the device is broken or damaged, precautions must be taken against the following hazards which may arise:

- Broken glass. Protective clothing, such as rubber gloves, should be used.
- Contamination by photocathode and fluorescent screen materials. In particular, skin contact and inhalation of these materials should be avoided.
- Disposal by incineration. This is not recommended as toxic fumes may be given off. When any other method of disposal is used, the warnings given above must be observed and care should be taken to avoid environmental pollution.

7 ADDITIONAL INFORMATION

Comprehensive details of the mode of operation and the usage of image intensifiers are given in the publication entitled "Technical Information – Image Intensifiers".

8 *WARNING*

Image intensifiers are very high vacuum devices, and any deterioration in the vacuum will lead to a shortening of their useful life. Because intensifiers are permeable to helium it is imperative that they are not subjected to excessive concentrations of this gas. This is particularly important when the equipment incorporating the intensifier is being purged. Helium-free gas must be used for this operation.

SURVEY OF TYPES

Image intensifiers, typical values

category and types	input/output diameter mm	input	output	power supply unit	gain	photocathode sensitivity white μA/lm	800 nm mA/W	850 nm mA/W	MTF at l_p/mm 2,5 %	7,5 %	15 %	optical length mm	mass g	page
A. Electro-optic inverter types														
XX1332	50/40	FO	FO	incl.	45 000	320	28	17	86	63	30	99	850	11
XX1380	20/30	FO	FO	incl.	22 000	350	35	30	96	81	53	80	350	24
XX1380FL	20/30	FO	FO	incl.	22 000 adj.	350	35	30	96	81	53	80	350	24
XX1381	20/30	FO	FO	incl.	22 000	350	35	30	96	81	53	80	350	25
XX1381FL	20/30	FO	FO	incl.	22 000 adj.	350	35	30	96	81	53	80	350	25
XX1387	20/30	FO	FO	n. incl.	22 000	350	35	30	96	81	53	80	330	26
XX1500	18/18	FO	FO	incl.	5-50 000 adj.	350	35	25	92	67	33	54,6	180	51
XX1500TV	15 x 11/18	FO	FO	incl.	5-65 000 adj.	350	35	25	92	67	33	54,6	180	49
XX1501	18/18	FO	FO, concave	incl.	5-50 000 adj.	350	35	25	92	67	33	53,4	180	52
XX1502	18/18	FO	FO	n. incl.	1-10 000 adj.	350	35	25	92	67	33	54,6	300	53
B. Proximity focused types														
XX1390	18/18	glass	glass, n. inv.	n. incl.	15 000 adj.	400	35	30	29 lp/mm			4	40	28
XX1410	18/18	FO	FO, concave inv.	incl.	10 000	420	40	30	89	60	30	26,6	<100	34
XX1410/SP10005-201	18/18	glass	FO, concave inv.	incl.	15 000	450	40	30	90	62	30	20	<75	35
XX1410/SP20103-260	18/18	FO	FO, concave inv.	incl.	10 000	420	40	30	89	60	30	26,6	<100	39
XX1410/SP20121-210	18/18	FO	FO, flat n. inv.	n. incl.	15 000 adj.	420	40	30	89	60	30	21	<80	40
XX1410/SP20122-210	18/18	FO	FO, flat n. inv.	incl.	10 000	420	40	30	89	60	30	21	<100	42

IMAGE INTENSIFIER

The XX1332 is an electrostatically self-focused, inverting microchannel plate image intensifier which incorporates an integral power supply. With a 50 mm optic input window and a 40 mm fibre optic output window it gives a large format high resolution image, enabling a single bi-ocular output eyepiece to be used. This makes the intensifier particular suitable for surveillance or vehicle-borne night vision applications. Other features of this intensifier include automatic gain control, bright source protection (due to point highlight saturation), automatic brightness control and very fast recovery from exposure to high light levels.

This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	48,8	mm
Material		plane fibre optic	
Output			
Screen phosphor		P20, aluminized	
Useful diameter	min.	38,8	mm
Material		plane fibre optic	
Optical length	nom.	98,7	mm
Recommended supply voltage		6,5	V
Input current	typ.	32	mA
	max.	50	mA
Mass	max.	850	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	250	320		μA/lm
λ = 800 nm	20	28		mA/W
λ = 850 nm	10	17		mA/W
Luminance gain, ϕ_G = 25 mm, $E_i \approx 50$ μlx	30 000	45 000*	60 000	
Mean screen luminance, ϕ_G = 22,5 mm, $E_i \approx 20$ mlx	4,0	6,5	8,0	cd/m²
Equivalent background illumination (EBI)		0,08	0,20	μlx
Resolution				
centre	18	23		lp/mm
edge, ϕ_E = 28 mm	18	20		lp/mm
Magnification				
centre, ϕ_d = 4,0 mm	0,62	0,66	0,71	
edge, ϕ_D = 40 mm	0,71	0,74	0,77	

* Preset by manufacturer.

CHARACTERISTICS (continued)

	min.	typ.	max.	
Modulation transfer factors**				
5 cycles/mm	80	86		%
10 cycles/mm	55	63		%
20 cycles/mm	20	30		%
Veiling glare		0,8	1,0	%
Distortion, ϕ_D = 40 mm		10		%
Image alignment			2,0	mm
Recovery time		0,2	0,5	s
Brightness uniformity			3:1	
Mounting position		any▲		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage			
continuous	6,75		V
instantaneous	7,0		V
Photocathode illuminance	1,0		lx
Ambient temperature			
for storage, 100 h cumulative	70	−20	°C
for operation and long term storage	35	−20	°C
for operation, 2 h max.	52	−40	°C
Axial forces between bearing surfaces	150		N

Note: If the supply voltage falls below 6,0 V, the intensifier may not function, but will not be damaged. If the supply voltage is reversed up to 60 s, the intensifier will not function, but will not be damaged.

QUALIFICATION APPROVAL

Qualification approval to DEF STAN 59-60/90/089, Issue 2, September 1980 has been obtained. Testing of the various characteristics is normally carried out as required by that specification. Intensifiers can be supplied with certificates of conformity to the DEF STAN specification.

WARNING

Immediately after operation, the screen will remain electrostatically charged for approximately 1 minute, during which time the intensifier should not be handled. Any attempt to discharge the intensifier by any means may result in irreparable damage.

ENVIRONMENTAL TESTS

Shock	6 shocks, half-sinewave, pulses of peak acceleration 981 m/s^2, duration 6 ms, in 3 mutually perpendicular directions.
Vibration	Sinewave, displacement 0,15 mm over frequency range 10 to 58 Hz, peak acceleration 19,6 m/s^2 over frequency range 58 to 150 Hz, in 3 mutually perpendicular directions.
Temperature cycle	8½ h cycle including 1½ h storage at −40 °C, 2 h storage at +70 °C, operation at 52 °C and 22 °C.

** These values are normalized at zero spatial frequency and are referred to the screen.

▲ Force on supply contacts must not exceed 10 N.

PHOTOCATHODE ILLUMINANCE

Recommended level	max. 10 mlx. The intensifier may be used at illumination levels up to 1,0 lx but for continuous operation the recommended maximum illumination is 10 mlx.
Room lighting	no damage, with no applied voltage.
Point light sources such as car lights tracers, flashers, etc.	no damage.

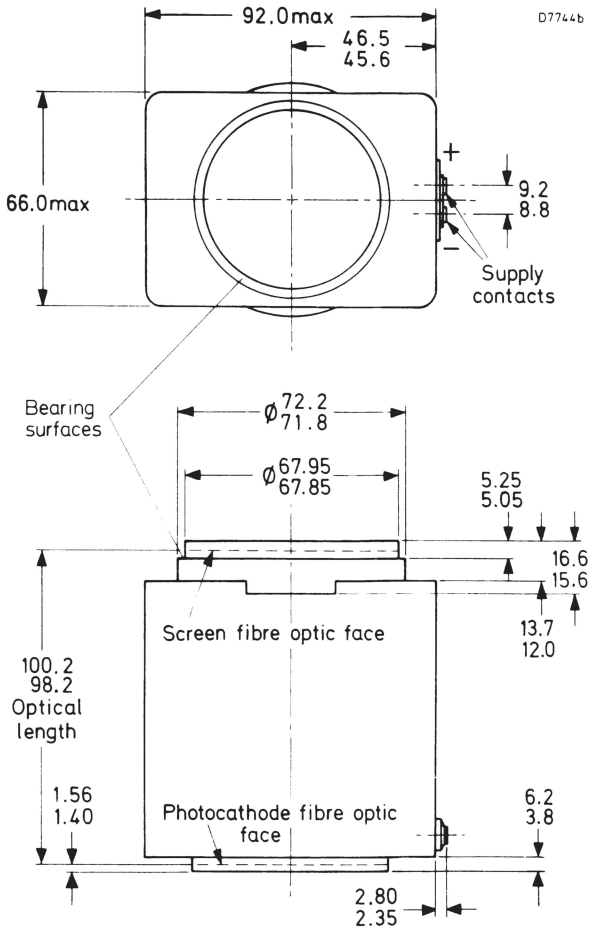
Prolonged operation with illuminance exceeding 10 mlx can reduce the life of the intensifier. This corresponds to the scene illuminance of deep twilight when the intensifier is incorporated in a typical sight.

LIFE EXPECTANCY

Cathode illumination	
1 mlx	min. 2000 h
100 μlx	min. 5000 h

MECHANICAL DATA

Dimensions in mm



Force on supply contacts must not exceed 10 N

Fig. 1 Outline drawing.

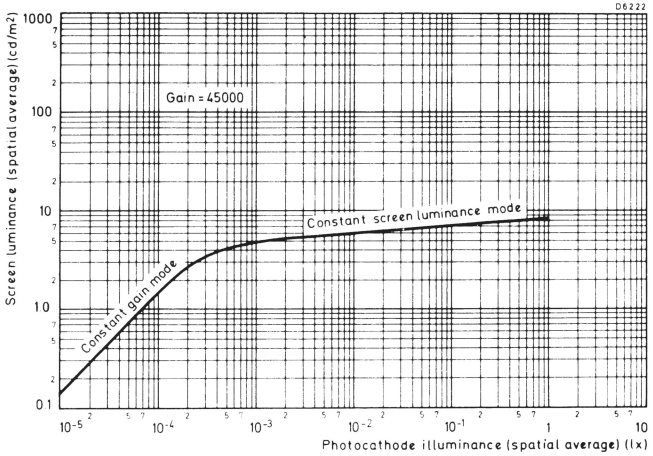


Fig. 2 Typical automatic brightness control characteristic.

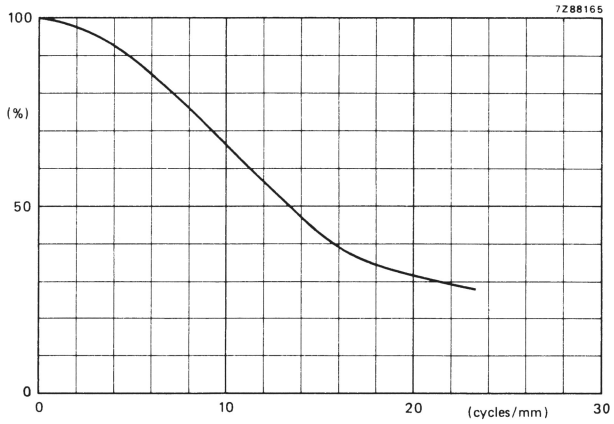


Fig. 3 Typical MTF curve.

IMAGE INTENSIFIERS

The XX1380 series image intensifiers are self-focusing magnifying compact microchannel plate image intensifiers with integral power supply, incorporating automatic gain control, intended for use in light-weight night vision systems for visible light and near-infrared radiation. Particular features of these intensifiers include point highlight saturation, high resolution and precision engineered surfaces. The intensifiers have plane fibre-optic input and output windows and a medium-long persistance phosphor screen.

This data must be read in conjunction with General Introduction Image Intensifiers.

The XX1380 family consists of:

XX1380 the basic version, mixed screen phosphor.
XX1380FL as XX1380, but with flying leads and adjustable luminance gain, note 1.
XX1381 as XX1380, but with P20 screen phosphor.
XX1381FL as XX1381, but with flying leads and adjustable luminance gain, note 1.
XX1387 as XX1381, but without integral power supply.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	19,5	mm
Material		fibre-optic	
Output			
Screen phosphor XX1380, XX1380FL	P20/P39 mixed, aluminized		
XX1381, XX1381FL, XX1387	P20, aluminized		
Useful diameter	min.	30	mm
Material		fibre-optic	
Optical length	nom.	80,1	mm
Recommended supply voltage (note 2)		2,6	V
Input current (note 2)	max.	30	mA
Mass	max.	350	g

Photocathode	**min**	typ.	
Sensitivity, measured before P.S.U. is fitted, white-light, colour temperature 2856K	240	350	μA/lm
λ = 800 nm	20	35	mA/W
λ = 850 nm	15	30	mA/W
Useful diameter	19,5		mm
Material	fibre-optic		
Screen			
Screen phosphor XX1380, XX1380FL	P20/P39 mixed, aluminized		
XX1381, XX1381FL, XX1387	P20, aluminized		
Overall phosphor persistance			
mixed phosphor	medium long		
P20 phosphor	medium		

Fluorescence		green		
Useful diameter	min.	30		mm
Material		fibre-optic		
Optical length	min.	79,8		mm
	max.	80,4		mm

CHARACTERISTICS

Measured at 25 ± 5 °C with recommended supply voltage

	min.	typ.	max.	
Luminance gain (note 3)				
ϕ_G = 7,5 mm, $E_i \approx 50$ µlx		22 000		
Mean screen luminance, $E_i \approx 10$ mlx, see Fig. 3	4		6	cd/m²
Equivalent background illumination (EBI)			0,20	µlx
Signal-to-noise ratio (note 4)				
XX1380, XX1380FL	4,5			
XX1381, XX1381FL	2,8			
Resolution				
centre	44	51		lp/mm
edge, ϕ_E = 16 mm	40	45		lp/mm
Magnification				
centre, ϕ_d = 2,5 mm		1,5		
Modulation transfer factor, reduced area (note 5)				
2,5 lp/mm	92	96		%
7,5 lp/mm	75	81		%
15 lp/mm	45	53		%
Veiling glare		1,5	5,0	%
Distortion, ϕ_D = 16 mm (note 6)		2	3	%
Image alignment			1,0	mm
Recovery time			0,5	s
Image shift		0,02	0,15	mm
Mounting position		any		
Output brightness uniformity (white light)			2,5:1	

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

	max.	min.	
Supply voltage (note 7)	3,4		V
Photocathode illuminance, max. 1 h (note 8)	5000		lx
Ambient temperature			
for operation and long term storage	52	−40	°C
for operation, 2 h max.	68	−55	°C
Axial forces between bearing surfaces (note 9)	250		N

SHOCK AND VIBRATION RESISTANCE

The following test conditions are supplied on a sampling basis to access the mechanical quality of the intensifiers.

Shock 1

The device with the operating voltage applied is subjected 6 times to a peak acceleration of 500 g in each of the following directions:
a. parallel to the mechanical axis,
b. perpendicular to mechanical axis.

Pulse shape: half-sinusoidal, pulse duration: 0,30 ± 0,05 ms measured between the 10% of the peak amplitude values.

Shock 2

The device with the operational voltage applied is subjected 6 times to a peak acceleration of 140 g in each of the following directions:
a. parallel to the mechanical axis,
b. perpendicular to the mechanical axis.

Pulse shape: half-sinusoidal, pulse duration 9,0 ± 0,05 ms measured between the 10% of the peak amplitude values.

Shock 3 (bump test)

The device with no voltage applied is subjected 2000 times to a peak acceleration of 40 g in each of the following directions:
a. parallel to the mechanical axis,
b. perpendicular to the mechanical axis.

Pulse shape: half-sinusoidal, pulse duration 6 ± 2 ms and 2 to 4 shocks per second.

Vibration

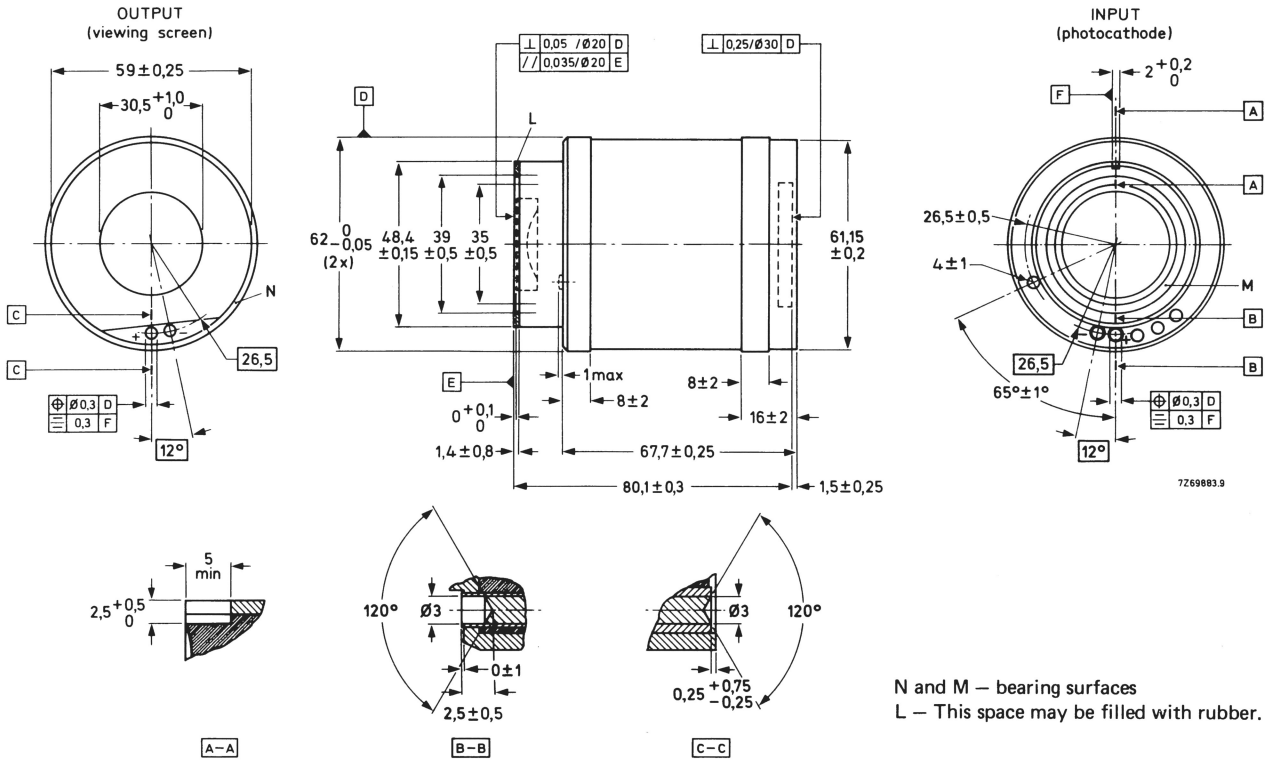
The device is subjected to a vibration frequency of 10 Hz to 3500 Hz with an acceleration of 2,5 g in the following directions:
a. parallel to the mechanical axis,
b. perpendicular to the mechanical axis.

Duration of vibration: 30 minutes. Sweep rate: 10 Hz to 3500 Hz in a logarthmic sweep rate of 30 minutes.

PACKAGING

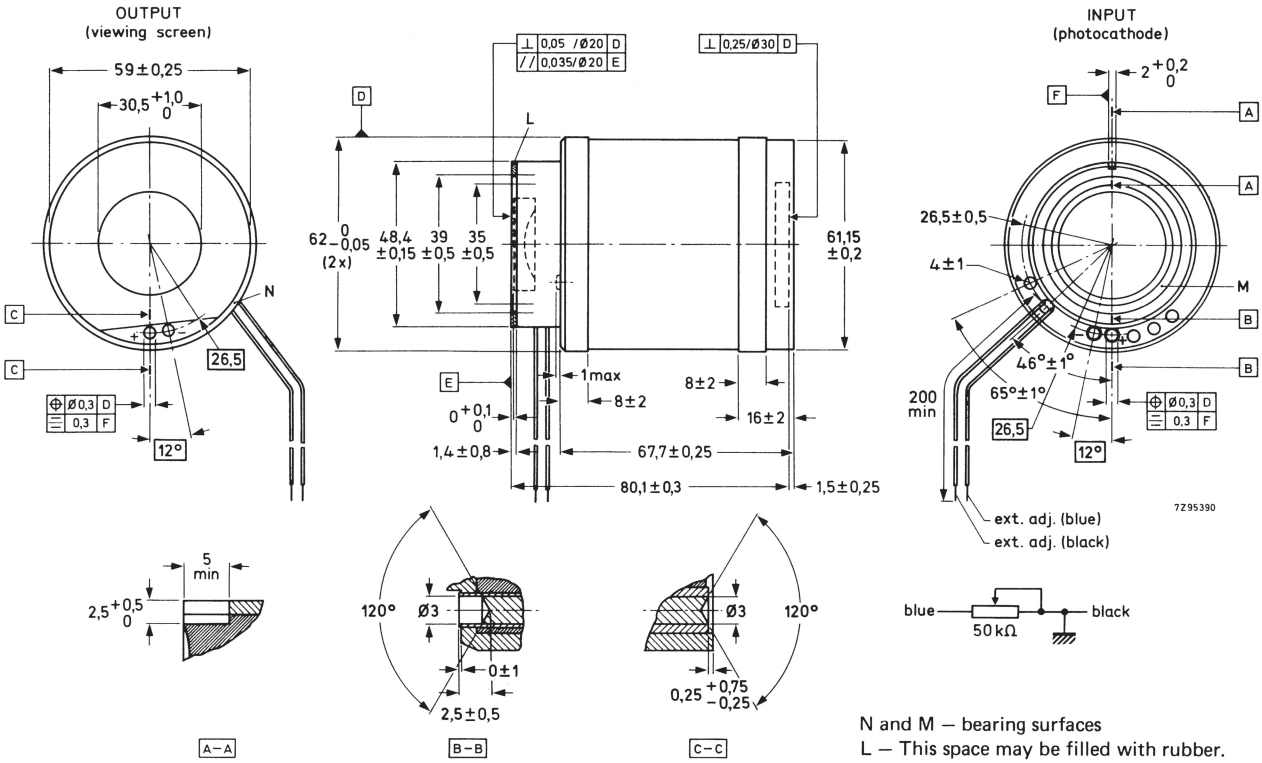
The tubes are individually packed in an hermetically sealed tin, filled with nitrogen. This tin should not be opened before use.

MECHANICAL DATA



N and M — bearing surfaces
L — This space may be filled with rubber.

Fig. 1 Outline drawing XX1380/XX1381.



N and M — bearing surfaces
L — This space may be filled with rubber.

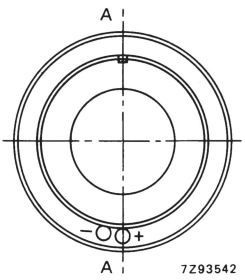
Fig. 2 Outline drawing XX1380FL/XX1381FL.

Notes

1. The user can vary the luminance gain up to the preset value by means of a 50 kΩ variable resistor.
2. Recommended supply voltage and input current except for XX1387 delivered without integral power supply.
3. Upon request the luminance gain can be set at other values.
4. The signal-to-noise ratio is measured by uniformly illuminating, with illuminance E_i, a circular spot of known area on the photocathode. The resultant output photocurrent from the screen is filtered with a four-pole Butterworth low-pass filter set for a 3 dB point at 20 Hz. The output from the filter is measured with a d.c. and r.m.s. meter. The combination of the filter and the P20 phosphor has a bandwidth of 17,5 Hz. Signal-to-noise ratio is defined as:

$$\frac{S}{N} = K \frac{S_o - S_b}{\sqrt{(N_o^2 - N_b^2)}} \cdot \sqrt{\left(\frac{1{,}24 \times 10^{-5}}{E_i} \times \frac{3{,}14 \times 10^{-8}}{A} \right)}$$

   K = correction factor for filter (1,32), to obtain equivalent bandwidth of 10 Hz.
   N_o = r.m.s. signal output.
   S_o = d.c. signal output.
   N_b = r.m.s. signal output } when the intensifiers photocathode is capped.
   S_b = d.c. signal output }
   E_i = photocathode illuminance.
   A = area of circular spot.
5. Measuring the modulation transfer factor in a reduced area gives a negligible low-frequency drop. The measurement is referred to the centre of the photocathode in A-A direction.



6. The same limits also apply at ϕ_D = 19 mm.
7. The tube will operate at any supply voltage from 2,2 V to 3,4 V. If the supply voltage falls below 2,2 V, the intensifier may not function, but will not be damaged. If the supply voltage is reversed for up to 60 s, the intensifier will not function, but will not be damaged.
8. Exposure to focused intense light or infrared radiation should be avoided.
9. The intensifier should be mounted only between bearing surfaces M and N. Surface M is defined by the diameters 39 mm and 35 mm at the photocathode end. Surface N is defined by the diameters 59 mm and 61 mm at the screen end.

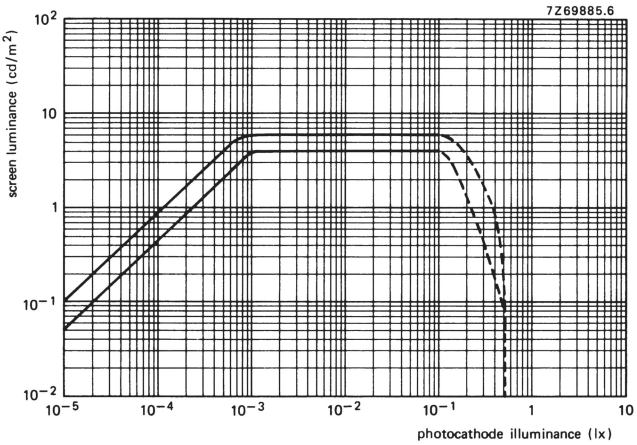


Fig. 3 Maximum and minimum screen luminance as a function of photocathode illuminance.

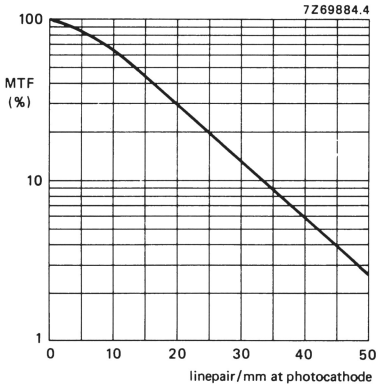


Fig. 4 Reduced area modulation transfer characteristic.

IMAGE INTENSIFIERS

This intensifier conforms to the specification of the XX1380-series. For this reason only changes and/or additions, relevant to XX1380 (XX1380FL) are given in this data sheet.

QUICK REFERENCE DATA

Overall phosphor persistence (mixed phosphor)	medium	long	
Input current	max.	30	mA

CHARACTERISTICS

Measured at 25 ± 5 °C with recommended supply voltage			
Mean screen luminance, ϕ_G = 7,5 mm, $E_i \approx$ 10 mlx		4 to 6	cd/m²
Signal-to-noise ratio	min.	4,5	
Ambient temperature (storage, 100 h cumulative)	max.	68	°C
Recovery time		0,5	S

Note: The image intensifier XX1380FL is identical to XX1380 but has so called flying leads. With the help of a variable resistor of 50 kΩ the customer can vary the luminance gain up to the preset value.

IMAGE INTENSIFIERS

This intensifier conforms to the specification of the XX1380-series. For this reason only changes and/or additions, relevant to XX1381 (XX1381FL) are given in this data sheet.

QUICK REFERENCE DATA

Overall phosphor persistance (P20)	medium	
Input current	max.	30 mA

CHARACTERISTICS

Measured at 25 ± 5 °C with recommended supply voltage

Mean screen luminance, ϕ_G = 7,5 mm, $E_i \approx$ 10 mlx		4 to 6 cd/m²
Signal-to-noise ratio	min.	2,8

Note: The image intensifier XX1381FL is identical to XX1381 but has so called flying leads. With the help of a variable resistor of 50 kΩ the customer can vary the luminance gain up to the preset value.

IMAGE INTENSIFIER

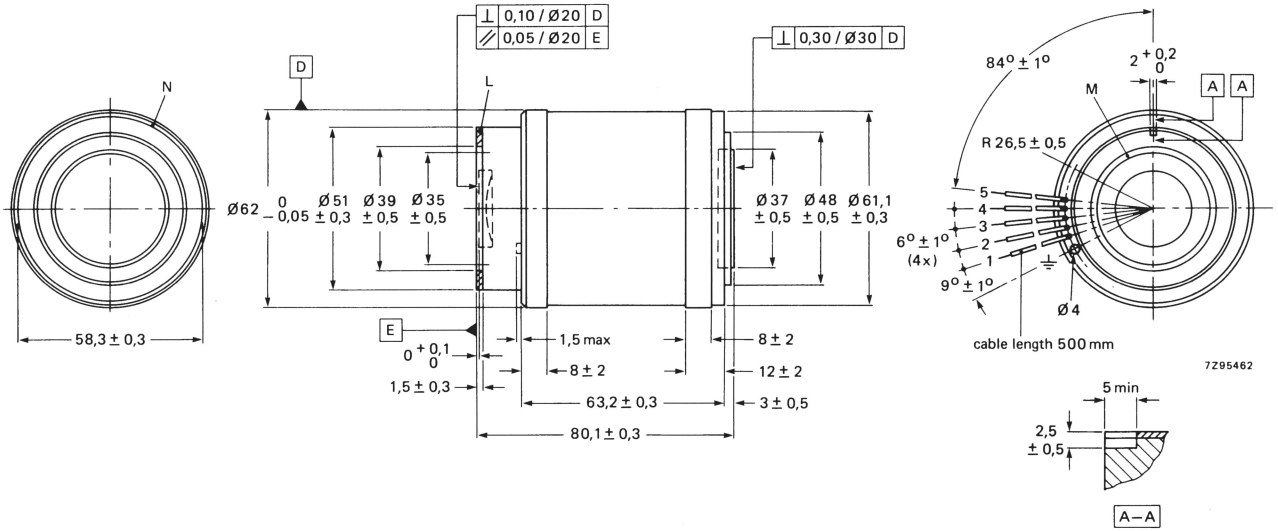
This intensifier conforms to the specification of the XX1380-series but does not incorporate a power supply. For this reason only changes and/or additions, relevant to XX1387 are given in this data sheet.

QUICK REFERENCE DATA

Overall phosphor persistence (P20)	medium
Recommended supply voltage (note 1)	
Anode to MCP output	2800 ± 100 V
Screen to MCP output (note 2)	3800 ± 100 V
MCP input to MCP output	−600 to −1000 V
Photocathode to MCP *input* (note 3)	−900 ± 50 V

Notes

1. The intensifier must not be touched by the operator because the presence of high voltage during operation. The metal piece of the viewing screen is not insulated.
2. If required for particular application the screen section may be put at earth potential. All other voltages should be changed accordingly.
3. The ripple (peak to peak) and rapid fluctuations should be kept within 2%.



N and M bearing surfaces

L This space may be filled with rubber

cable connections

1 = cathode

2 = anode (cone)

3 = MCP input

4 = MCP output

5 = screen

↓ = earth (container only)

IMAGE INTENSIFIER

The XX1390 image intensifier is a miniature, distortionless, electrostatic proximity focused microchannel plate image intensifier. No power supply is included in the encapsulation. It has 18 mm diameter plane glass input and output window. It is primarily intended for use in lightweight night vision goggles, but is suitable for many very low light level applications.

This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	18	mm
Material glass; refractive index 1,49 mm, thickness		1,5	mm
Output			
Screen phosphor		P20, aluminized	
Useful diameter	min.	18	mm
Material glass; refractive index 1,49, thickness		2	mm
Optical length		2	mm
Mass		40	g

CHARACTERISTICS

Measured at 20 ± 5 °C with recommended supply voltage

	min.	typ.	max.	
→ Sensitivity				
white light	220	400		μA/lm
λ = 800 nm	12	35		mA/W
λ = 850 nm	4	30		mA/W
Luminance gain, ϕ_G = 140 mm, $E_i \approx 100$ μlx measured with PSU fitted (note 2)	7500		15 000	
Mean screen luminance			10	cd/m²
Equivalent background illumination (EBI)			0,5	μlx
Signal-to-noise ratio (note 3)	2,5			
Resolution				
centre	25	29		lp/mm
edge, ϕ_E = 14 mm	25	29		lp/mm
Magnification		1,000		
Mounting position		any		
Output brightness uniformity (white light)			3 : 1	

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage			
MCP input to photocathode	150		V
MCP output to input	900		V
Screen to MCP output	6		kV
Photo cathode illuminance			
Continuous	10		mlx
Short periods	20		mlx
Ambient temperature			
for storage, 2 h max.	65	−55	°C
for long term storage	27	−55	°C

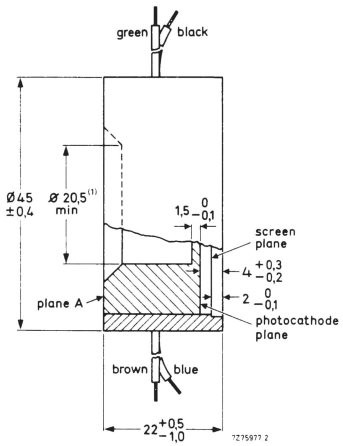
Notes

1. Recommended operating conditions:
   Voltages

MCP input to photocathode		50 ± 100	V
MCP output to input		700 ± 200	V
Screen to MCP output		5700 ± 300	V
MCP resistance at + 20 °C	min.	150	MΩ
Photocathode illuminance, continuous		10	mlx
Relative humidity		35 to 50	%

   Each tube is accompanied by a test result sheet giving the recommended operating conditions. Particular attention should be paid to the maximum MCP voltage.
2. The gain is adjusted by varying the value of the microchannel plate voltage, see Fig. 2.
3. Input illumination 12,5 μlx, ϕ 0,2 mm, bandwidth 20 Hz.
4. The intensifier is encapsulated in a soft plastic housing. Four electrical leads exit from this housing. Their functions are:
   black: microchannel plate output
   blue: photocathode
   brown: screen
   green: microchannel plate input

MECHANICAL DATA



* This dimension is guaranteed not to exceed a depth of 11,5 mm from plane A.

Fig. 1 Outline drawing.

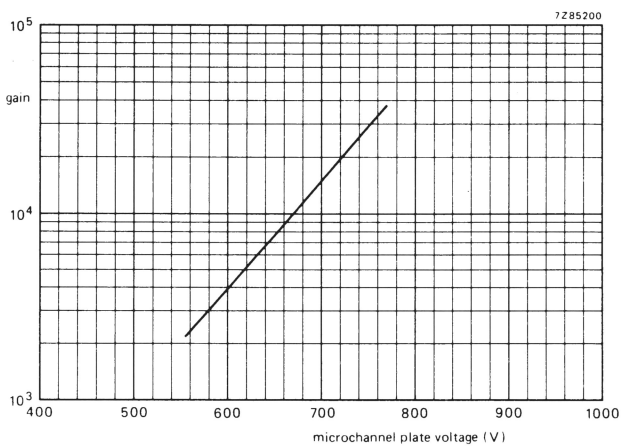


Fig. 2 Typical luminous gain characteristic.

IMAGE INTENSIFIERS

The XX1410-series image intensifiers are miniature, distortionless, double electrostatic proximity focused microchannel plate image intensifiers with 18 mm optic input window and 18 mm fibre optic output window, either straight or inverting (twisted), plane or concave.

The integral power supply incorporates automatic gain control. Point highlight saturation and bright source protection are features of this intensifier. It is primarily intended for use in lightweight night vision goggles, but is also suitable for many very low light level applications.

This data must be read in conjunction with General Introduction Image Intensifiers.

The XX1410 family consists of:

- XX1410, the basic version with fibre optic input window, mixed screen phosphor on twisted and concave output window, electrical contacts.
- XX1410/SP10005-201, improved version of XX1410 but with glass input window and very small lightweight power supply.
- XX1410/SP20103-260, as XX1410 but with flying leads.
- XX1410/SP20121-210, as XX1410 but with straight and flat fibre optic output window and without power supply.
- XX1410/SP20122-210, as XX1410 but with straight and flat fibre optic output window.

For special applications S20 photocathode can be supplied instead of S25.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	17,5	mm
Material		fibre optic	
Output			
Screen phosphor		mixed phosphor	
Useful diameter	min.	17,5	mm
Material		fibre optic	
Recommended supply voltage (note 1)		2,7	V
Input current	typ.	10	mA
	max.	16	mA
Mass	max.	100	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity, measured before PSU is fitted				
white light	240	420		μA/lm
λ = 800 nm	20	40		mA/W
λ = 830 nm	18	35		mA/W
λ = 850 nm	12	30		mA/W

CHARACTERISTICS (continued)	min.	typ.	max.	
Luminance gain,				
ϕ_G = 17 mm, $E_i \approx$ 20 μlx	7500		15 000	
Mean screen luminance, see also Fig. 1				
ϕ_G = 17,0 mm, $E_i \approx$ 20 mlx	1,0		3,0	cd/m²
Equivalent background illumination (EBI)		0,15		μlx
Signal-to-noise ratio note 2	4,5	5,0		
Resolution				
centre	25	29		lp/mm
edge, ϕ_E = 14 mm	25	29		lp/mm
Magnification		1,000		
Modulation transfer factors				
2,5 lp/mm	86	89		%
7,5 lp/mm	58	60		%
15 lp/mm	20	30		%
Image alignment			0,4	mm
Rise time			5	s
Output brightness uniformity, white light			3 : 1	
Mounting position, note 3		any		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage	3,2		V
Photocathode illuminance			
Continuous	10		mlx
Short periods	20		lx
Ambient temperature			
for storage, 2 h max.	65	−55	°C
long term storage	27	−55	°C
for operation, continuous	35	−20	°C
for operation, 2 h max.	45	−45	°C
Axial forces between bearing surfaces	200		N

Notes

1. If the supply voltage falls below 2,0 V, but remains greater than −2,7 V, the intensifier may not function, but will not be damaged.
2. Initial measurement E_i = 12,5 μlx, ϕ 0,2 mm, bandwidth 10 Hz.
3. Force on supply contacts must not exceed 10 N.
4. It is recommended that exposure to relative humidity greater than 40% be avoided. Humidity may affect the intensifier operation either temporarily or definitively.

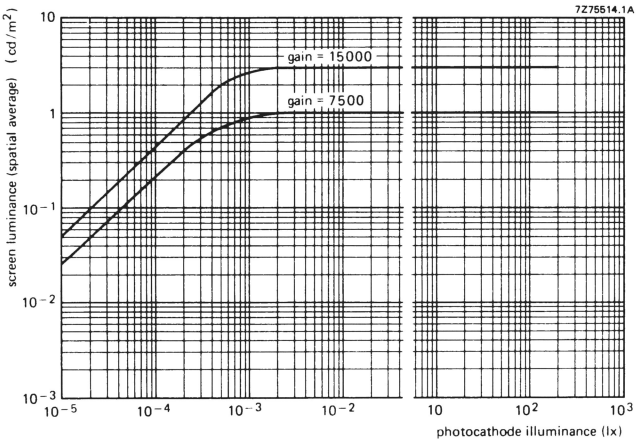


Fig. 1 Typical automatic gain control characteristic.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410 are given in this data sheet.

QUICK REFERENCE DATA

Output material	fibre optic, concave, inverting	
Optical length	typ.	26,6 mm

OUTLINES

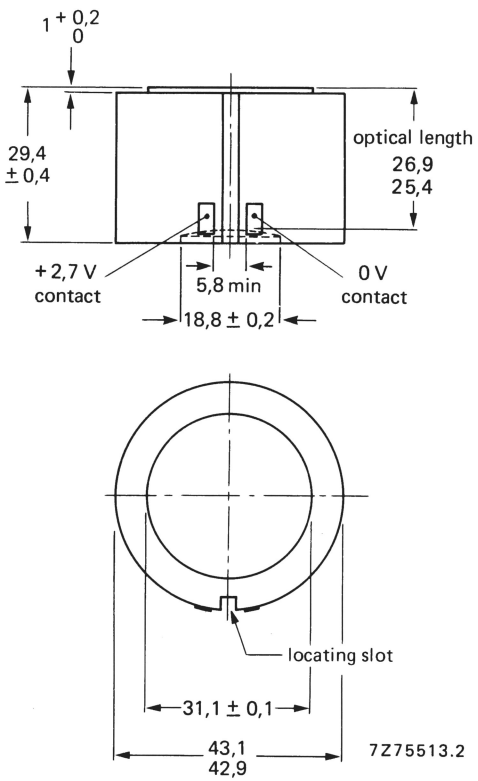


Fig. 1 Overall dimensions.

Radius of concave output window: 40,0 ± 0,1

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 5,6
width: 3,0
thickness: 0,2

IMAGE INTENSIFIER

The XX1410/SP10005-201 is a miniature, distortionless, double electrostatic proximity focused microchannel plate image intensifier with 18 mm glass input window and 18 mm inverting curved fibre optic output window. This tube is fully compatible with the 3rd generation U.S. "Anvis" tube. The very small power supply incorporates automatic gain control. Point highlight saturation and bright source protection are features of this intensifier. It is primarily intended for use in very lightweight high performance night vision goggles.
This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input		
Photocathode		S25
Useful diameter	min.	17,5 mm
Material		glass
Refractive index		1,49
Output		
Screen phosphor		P20
Useful diameter	min.	17,5 mm
Material		fibre optic
Optical length	nom.	20 mm
Recommended supply voltage		2,7 V
Input current	max.	45 mA
Outer diameter		36,78 mm
Mass	max.	85 g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity, measured before PSU is fitted				
white light	300	450		μA/lm
λ = 830 nm	20	35		mA/W
Luminance gain, ϕ_G = 17 mm, $E_i \approx 20$ μlx	7500		15000	
Mean screen luminance, ϕ_G = 17 mm, $E_i \approx 20$ mlx, see also Fig. 2	1,7		5	cd/m²
Equivalent background illumination (EBI)		0,15	0,25	μlx
Signal-to-noise ratio*	3,5	4,8		
Resolution				
centre	32	34		lp/mm
edge, ϕ_E = 14 mm	32	34		lp/mm
Magnification		1000		

* Initial measurement E_i = 12,5 μlx, ϕ 0,2 mm, bandwidth 10 Hz.

CHARACTERISTICS (continued)

	min.	typ.	max.	
Modulation transfer factors				
2,5 lp/mm	87	90		%
7,5 lp/mm	59	62		%
15 lp/mm	25	30		%
Image alignment			0,16	mm
Output brightness uniformity, white light			3 : 1	
Mounting position, note 2		any		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage	3,0	2,0	V
Photocathode illuminance			
continuous	10		mlx
instantaneous	20		lx
Ambient temperature			
for storage, 2 h max.	65	−55	°C
for long term storage	27	−55	°C
for operation, continuous	35	−20	°C
for operation, 2 h max.	45	−45	°C
Axial forces between bearing surfaces	200		N

NOTES

1. If the supply voltage falls below 2,0 V, but remains greater than −2,7 V, the intensifier may not function, but will not be damaged.
2. Force on supply contacts must not exceed 10 N.
3. It is recommended to avoid exposure to relative humidity greater than 40%. Humidity may affect the intensifier operation either temporarily or definitively.
4. Bearing surfaces are flat plastic surfaces on both ends of the intensifier. It is recommended to operate the intensifier in a metallic assembly which is electrically connected to the negative terminal of the intensifier supply. Metallic parts should be at least 1 mm of the optical surfaces.

OUTLINES

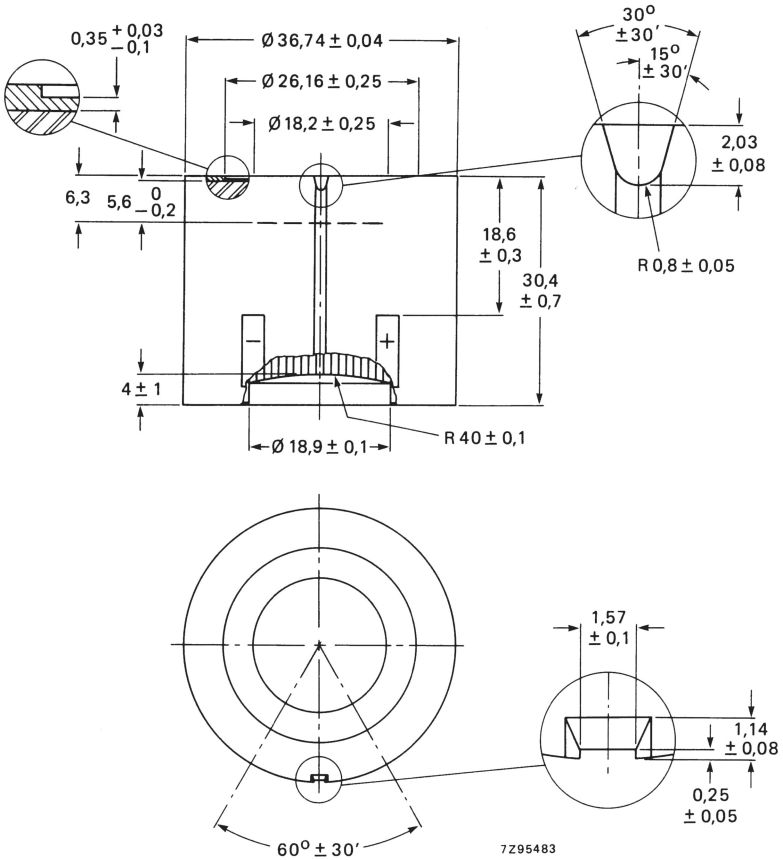


Fig. 1 Overall dimensions.

Radius of concave output window: 40 ± 1

Contact length : 9,5 ± 0,2

Contact width : 3,2 ± 0,1

DEVELOPMENT DATA

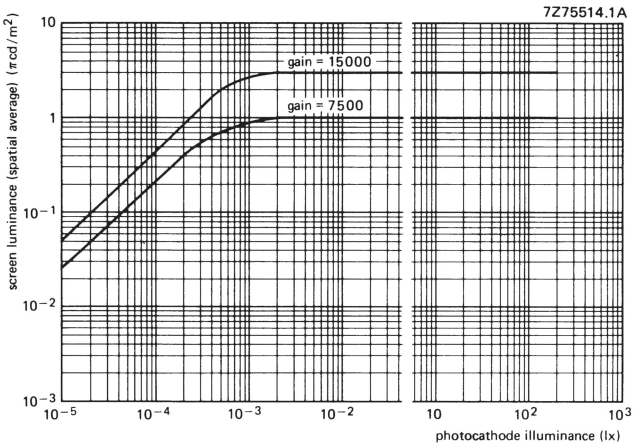


Fig. 2 Typical automatic gain control characteristic.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410/SP20103-260 are given in this data sheet. Type XX1410/SP20103-260 is a XX1410 with flying leads instead of contacts.

QUICK REFERENCE DATA

Output material	fibre optic, concave, inverting	
Optical length	typ.	26,6 mm

OUTLINES

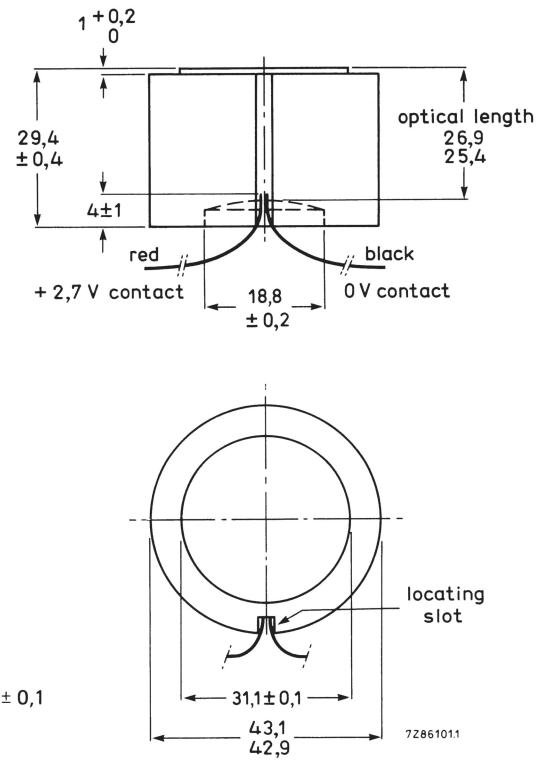


Fig. 1 Overall dimensions.

Radius of concave output window 40,0 ± 0,1

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 250 min.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410/SP20121-210 are given in this data sheet. Type XX1410/SP20121-210 has a flat, straight fibre-optic output window and does not incorporate a power supply.

QUICK REFERENCE DATA

Output			
material		fibre optic, flat, straight	
Optical length	typ.	21	mm

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

Supply voltage	max.		
MCP input to photocathode		300	V
MCP output to input		1000	V
screen to MCP output		6000	V
Photocathode illuminance			
continuous		10	mlx
instantaneous		20	lx
Screen luminance		5	cd/m^2

RECOMMENDED WORKING CONDITIONS

Supply voltage			
MCP input to photocathode		50 to 300	V
MCP output to input		800 ± 200	V
screen to MCP output		4500 to 6000	V
MCP resistance at 20 °C	min.	150	MΩ
Mean screen luminance		2	cd/m^2

Each tube is accompanied by a test result sheet giving the recommended operating conditions and the maximum MCP voltage.

The gain is adjusted by varying the value of the microchannel plate voltage. Particular attention should be paid to the maximum MCP voltage mentioned.

OUTLINES

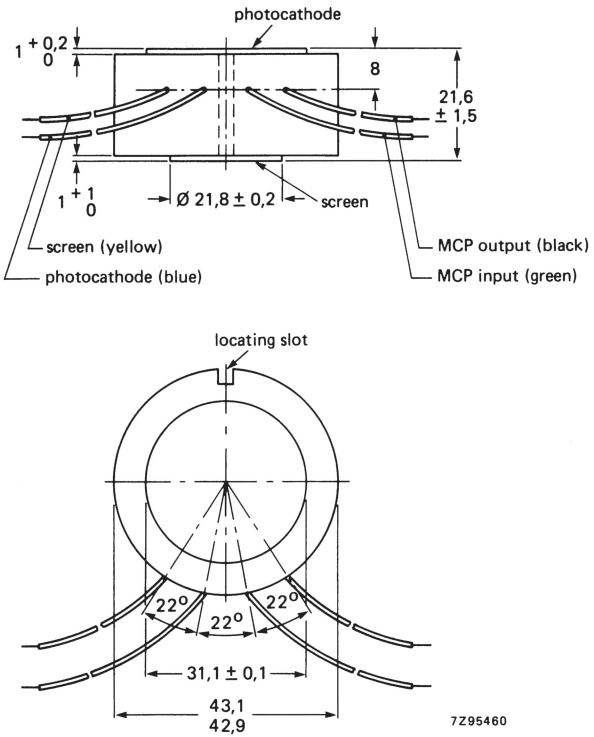


Fig. 1 Overall dimensions.

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 250 min.

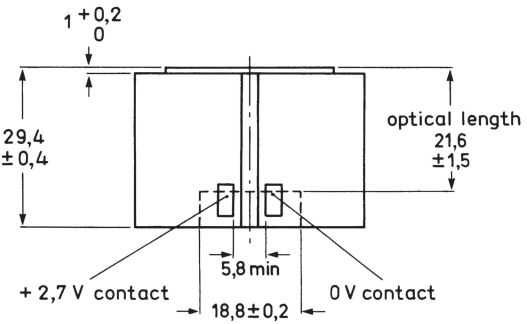
IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1410-series. For this reason only changes and/or additions, relevant to XX1410/SP20122-210 are given in this data sheet. Type XX1410/SP20122-210 has a flat, straight fibre-optic output window.

QUICK REFERENCE DATA

Output material	fibre optic, flat, straight	
Optical length	typ.	21 mm

OUTLINES



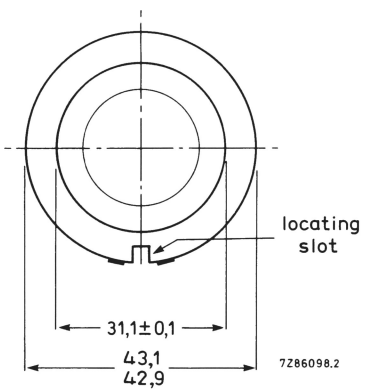


Fig. 1 Overall dimensions.

Locating slot depth: 2,8 min.
width: 2,8 min.

Contact length: 5,6
width: 3,0
thickness: 0,2

IMAGE INTENSIFIERS

The XX1500-series is a family of miniature, electrostatically self-focused, inverting microchannel plate image intensifiers. They have plane 18 mm input and output windows and an integral power supply with automatic gain control (AGC). Particular features include a S25 photocathode, external adjustment of gain, bright source protection (thanks to point highlight saturation) and low distortion.

This data must be read in conjunction with General Introduction Image Intensifiers.

The XX1500 family consists of:

- XX1500 the basic version, for use in direct viewing night vision systems,
- XX1500TV a high gain version fitted with a photocathode mask, intended for use as preamplifier for very low light television camera applications,
- XX1501 as XX1500 but with a concave fibre optic screen, allowing use of wafer tube eye-pieces,
- XX1502 fitted with a photocathode mask, a resistor network allowing external high voltage supply and primarily intended for fibre optic coupled LLL TV systems.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful diameter	min.	17,5	mm
Material		plane fibre optic	
Output			
Screen phosphor		P20, aluminized	
Useful diameter	min.	17,5	mm
Material		plane fibre optic	
Optical length	nom.	54,6	mm
Recommended supply voltage		2,6	V
Input current	max.	25	mA
Mass	max.	180	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	280	350		μA/lm
λ = 800 nm	28	35		mA/W
λ = 850 nm	15	25		mA/W
Luminance gain, ϕ_G = 10 mm, $E_i \approx 50$ μlx				
gain control at maximum	30 000	45 000	70 000	
gain control at minimum	2 000		10 000	
Mean screen luminance,				
ϕ_G = 10 mm, $E_i \approx 20$ mlx	5,0		10,0	cd/m²
Equivalent background illumination (EBI)			0,20	μlx

CHARACTERISTICS (continued)	min.	typ.	max.	
Signal-to-noise ratio	3,0	3,8		
Resolution				
centre	32	36		lp/mm
edge, ϕ_E = 14 mm	32	36		lp/mm
Magnification, any position	0,94		1,02	
Distortion, ϕ_d = 1,44 mm; ϕ_D = any		4		mm
Modulation transfer factors, values normalized to zero spatial frequency and referred to the screen				
2,5 cycles/mm	85	92		%
7,5 cycles/mm	65	67		%
16 cycles/mm	30	33		%
Veiling glare			2,0	%
Image alignment		0,8		mm
Recovery time		0,5		s
Brightness uniformity			3 : 1	
Mounting position		any		

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage	3,4		
Photo cathode illuminance (see notes)	1,0		lx
Ambient temperature			
for storage, 100 h cumulative	70	−20	°C
for operation and long term storage	52	−20	°C
for operation, 2 h max.	52	−40	°C
Axial forces between bearing surfaces	100		N

Notes

If the supply voltage falls below 2,0 V, the intensifier may not function, but will not be damaged. If the supply voltage is reversed up to 60 s, the intensifier will not function, but will not be damaged.

Prolonged operations with illuminance exceeding 10 mlx can reduce the life of the intensifier. This corresponds to a scene illuminance of deep twilight when the intensifier is incorporated in a typical sight. However, operation of 2000 h can be expected with a photocathode illuminance of 1 mlx.

Connection diagram

→ Each intensifier in this series is supplied with a connector (see next page). XX1500 can be supplied with a P.T.F.E. annulus around the edge of the cathode window.

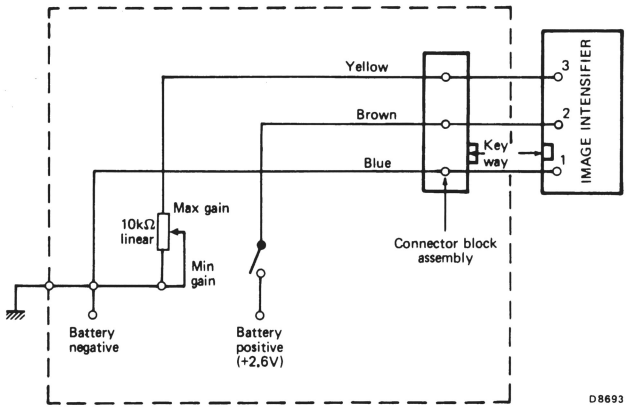


Fig. 1 Equipment wiring diagram.

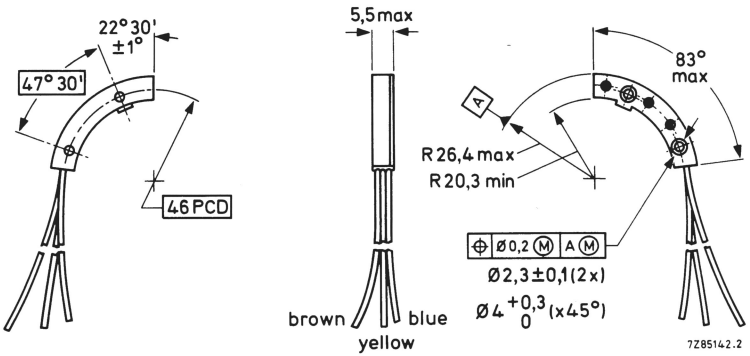


Fig. 2 Connector block assembly.
blue: earth/battery negative
brown: battery positive
yellow: customer gain control; 10 kΩ linear variable resistor to battery negative (R_S = 10 kΩ yields min. gain, R_S = 0 yields max. gain).

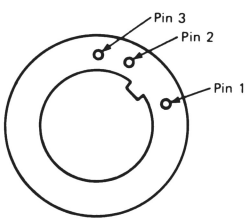


Fig. 3 Connections at photocathode end of intensifier.

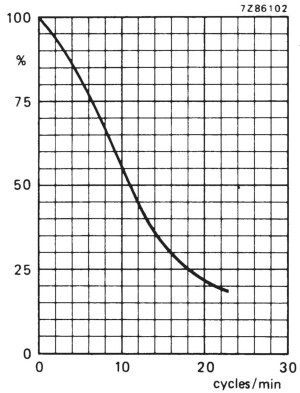


Fig. 4 Typical modulation transfer factor.

→ **MECHANICAL DATA,** see Fig. 5.

The mechanical axis is defined as the axis perpendicular to the pads plane 'A', which passes through the centre of the cathode reference ring diameter 'B' M.M.C.

The intensifier will fit into a cylinder of 53,00 diameter or greater, concentric with reference 'B' M.M.C. and sit on a plane perpendicular to the axis of that cylinder at room temperature.

Linear expansion coefficient of reference diameter 'B' and the intensifier sleeve (dimension 56 ± 1) is less than or equal to $100 \times 10^{-6}/K$.

The onus is on the customer to ensure that the maximum mounting forces are not exceeded throughout the operational temperature range.

WARNING

Immediately after operation, the screen will remain electrostatically charged for approximately 1 minute, during which time the intensifier should not be handled. Any attempt to discharge the intensifier by any means may result in irreparable damage.

ENVIRONMENTAL TESTS

Shock	6 shocks, half-sinewave, in two directions, parallel and perdendicular to the intensifier axis, with peak acceleration 1400 m/s^2, duration 9,0 ms.
Vibration	Sinewave, in two directions, parallel and perpendicular to the intensifier axis, with peak acceleration 25 m/s^2, over frequency range 10 to 3500 Hz.

Outline drawing

Dimensions in mm

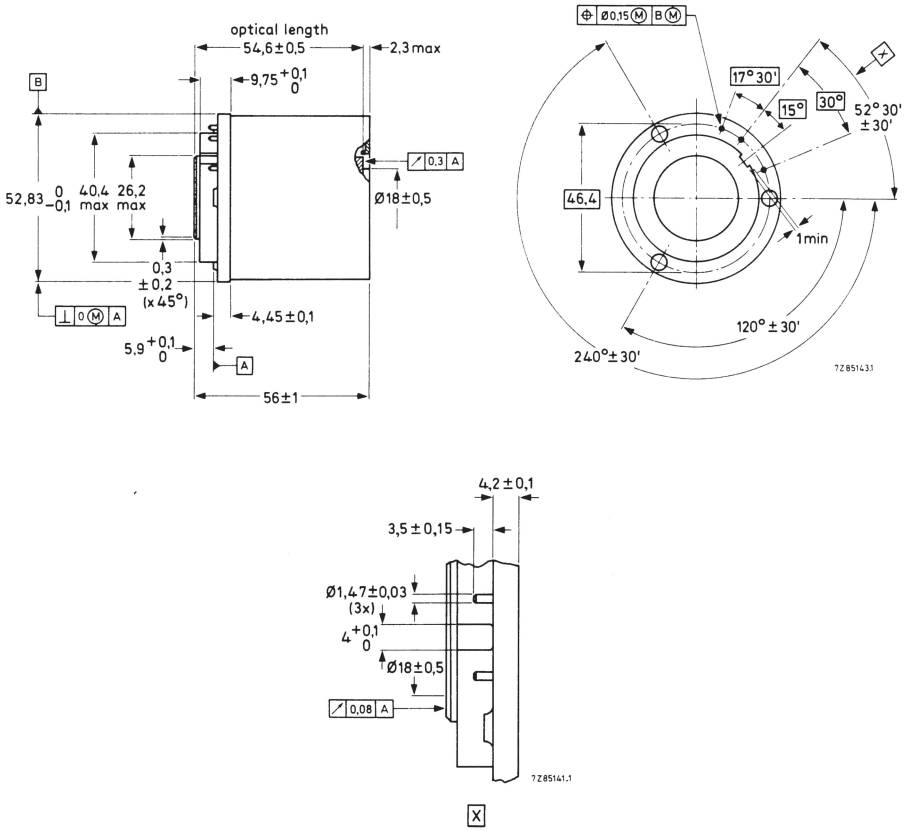


Fig. 5 Outlines of types XX1500, XX1500TV.
For XX1501 and XX1502 see also separate data sheet.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series. For this reason only changes and/or additions, relevant to XX1500TV are given in this data sheet.

The XX1500TV is a high gain version, fitted with photocathode mask. It is intended for use as a preamplifier for low level television camera applications.

QUICK REFERENCE DATA

Input current	max.	30	mA
Photocathode mask	see Fig. 1		

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

Gain, ϕ = 10 mm, $E_i \approx$ 20 mlx			
gain control at maximum	min.	65 000	
gain control at minimum	max.	5 000	
Mean screen luminance ϕ = 10 mm, $E_i \approx$ 20 mlx	min.	12	cd/m²
	max.	20	cd/m²

ACCESSORIES

Fibre optic insulator and extender plates enabling the XX1500TV to be fibre-optically coupled to a fibre-optic faceplate TV camera tube are available.

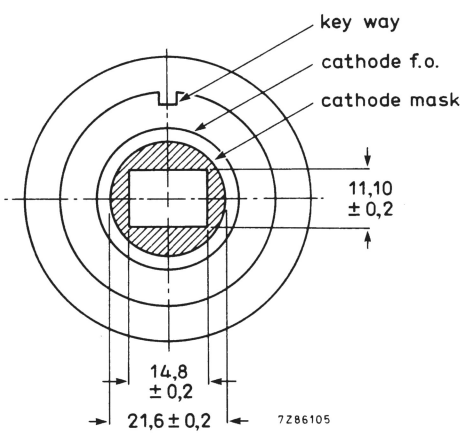


Fig. 1 Detail of photocathode end, showing mask.

Mask thickness $0{,}2^{+0{,}15}_{-0}$.

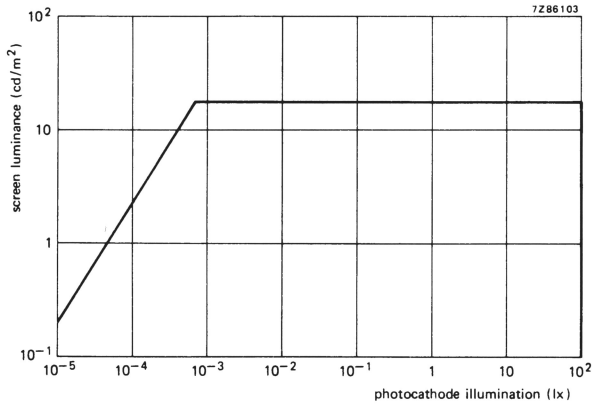
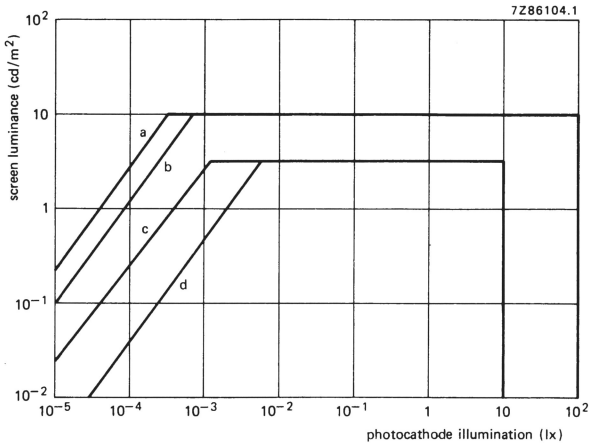


Fig. 1 Typical automatic gain control characteristics.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series. For this reason only changes and/or additions, relevant to XX1500 are given in this data sheet.



Typical automatic brightness control characteristics.

a = Maximum gain at max. setting.
b = Minimum gain at max. setting.
c = Maximum gain at min. setting.
d = Minimum gain at min. setting.

IMAGE INTENSIFIER

This intensifier conforms to the specification of the XX1500-series and XX1500. For this reason only changes and/or additions, relevant to XX1501 are given in this data sheet.

Featuring a concave fibre optic screen this intensifier is compatible with wafer tubes and therefore can make use of wafer tube eye-pieces.

QUICK REFERENCE DATA

Screen material	concave fibre optic
Optical length	nom. 53,4 mm

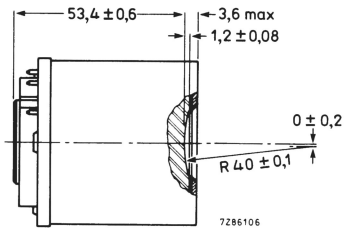


Fig. 1 Detail XX1501.

IMAGE INTENSIFIER

The XX1502 is a miniature, electrostatically self-focused, inverting microchannel plate image intensifier with plane 18 mm fibre-optic input and output windows, for use in low light level TV systems, fibre-optically coupled to the TV camera tube. It is fitted with a photocathode mask and has an integral resistor network to provide tube voltages from external high voltage supply. Gain is controlled by supply voltage, a screen current monitor lead is provided to facilitate automatic gain control. Particular features of this intensifier include type S25 photocathode, point highlight saturation, bright source protection and low distortion. ←

This data must be read in conjunction with General Introduction Image Intensifiers.

QUICK REFERENCE DATA

Input			
Photocathode		S25	
Useful area	min.	14,0 x 10,5	mm
Material		plane fibre optic	
Output			
Screen phosphor		P20	
Useful area	min.	14,0 x 10,5	mm
Material		plane fibre optic	
Optical length	nom.	54,6	mm
Supply voltage for gain = 10 000	nom.	7,5	kV
Input current	nom.	38	μA
Mass	max.	300	g

CHARACTERISTICS

Measured at 22 ± 3 °C with recommended supply voltage

	min.	typ.	max.	
Sensitivity				
white light	280	350		μA/lm
λ = 800 nm	28	35		mA/W
λ = 850 nm	15	15		mA/W
Input voltage for				
luminance gain = 10 000		7,5	7,8	kV ←
luminance gain = 1 000		6,5		kV
Input current, supply voltage 7,5 kV		38	50	μA
Screen current, for screen brightness 2,0 cd/m^2 (E_i = 5,0 mlx)		50	200	nA
Equivalent background illumination (EBI)			0,20	μlx
Magnification	0,94		1,02	
Distortion, ϕ_d = 1,44 mm; ϕ_D = any		4		%
Signal-to-noise ratio	3,0	3,8		

CHARACTERISTICS (continued)

	min.	typ.	max.	
Resolution				
centre	32	36		lp/mm
edge, ϕ_E = 14 mm	32	36		lp/mm
Modulation transfer factors, values normalized to zero spatial frequency and referred to the screen				
2,5 cycles/mm	85			%
7,5 cycles/mm	61			%
16 cycles/mm	27			%
Veiling glare			2,0	%
Image alignment			0,8	mm
Brightness uniformity			3 : 1	
Mounting position		any		

Recommended operating conditions

→ Supply voltage for gain control		6,4 to	7,8	kV
Photocathode illuminance, continuous operation	max.		5	mlx
Screen current		20 to	50	nA

RATINGS

Limiting values in accordance with the Absolute Maximum System IEC 134

	max.	min.	
Supply voltage, negative	8,2		kV
Photocathode illuminance, see note	1,0		lx
Screen current, see note	200		nA
Monitor impedance	100		MΩ
Ambient temperature			
→ for storage, 100 h cumulative	70	−30	°C
for operating and long term storage	52	−20	°C
for operation 2 h max.	52	−40	°C
Axial forces between bearing surfaces	100		N
→ between fibre optic and bearing surface	90		N

Note

Prolonged operation with illuminance exceeding 5 mlx and screen currents above 50 nA can reduce the life of the intensifier. Operation of 9000 h can be expected when used at the recommended operating conditions.

MECHANICAL DATA

The mechanical axis is defined as the axis perpendicular to the pads plane 'A' which passes through the centre of the cathode reference ring diameter 'B' MMC. The customer must ensure that the maximum axial force ratings are not exceeded throughout the operational temperature range. The linear expansion coefficient of reference diameter 'B' and intensifier sleeve (dimension 56,3 ± 0,5 mm) is less than, or → equal to 100×10^{-6}/K.

Connections

The white lead is the negative input. The grey coaxial lead is the positive input. The red inner lead is provided for monitoring screen current; if not required it should be connected to earth and positive input. Lead length 250 mm min. Diameter 4,0 mm max.

ENVIRONMENTAL TESTS

Shock 6 shocks, half-sinewave, pulses of peak acceleration 1400 m/s^2, duration 9 ms, in 2 directions, parallel and perpendicular to the intensifier axis.

Vibration Sinewave, peak acceleration 25 m/s^2 over frequency range 10 to 3500 Hz, in 2 directions, parallel and perpendicular to the intensifier axis.

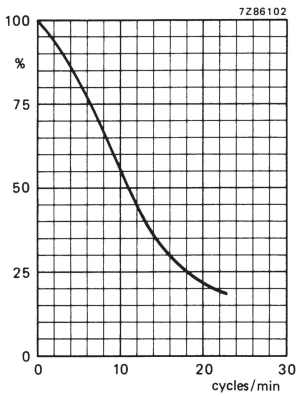


Fig. 1 Typical MTF curve.

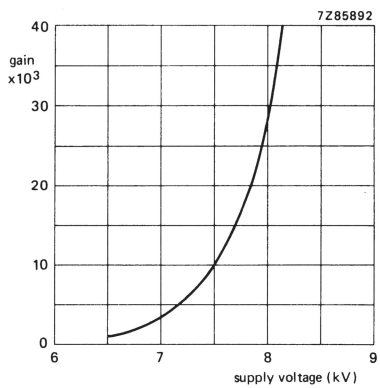


Fig. 2 Gain versus supply voltage, typical control characteristic.

OUTLINE DRAWING

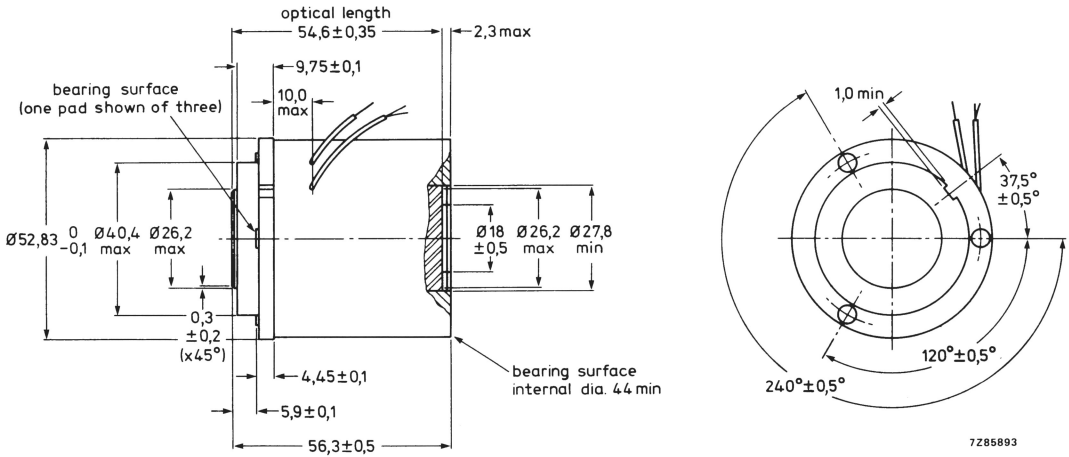


Fig. 3 Outlines of XX1502.

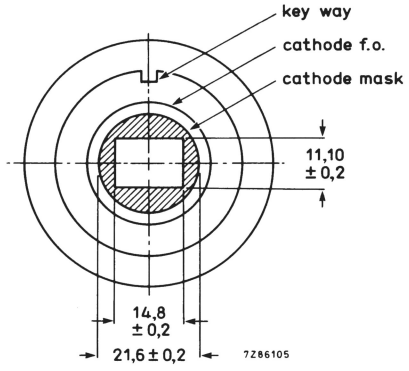


Fig. 4 Detail of photocathode end, showing mask.

Mask thickness $0,2 \begin{smallmatrix} +0,15 \\ -0 \end{smallmatrix}$.

INFRARED DETECTORS

INFRARED DETECTORS FOR THERMAL IMAGING

INTRODUCTION

Infrared detectors for thermal imaging consist of an infrared-sensitive semiconductor element housed in a metal/glass envelope. They normally operate in either the 3 to 5 μm or 8 to 14 μm waveband, these being the wavebands within which atmospheric attenuation is relatively low.

The most widely used detector material is photoconductive cadmium mercury telluride (CMT or MCT) – a semiconductor whose composition can be readily adjusted to attain maximum sensitivity in either of the two wavebands referred to above.

For optimum performance within these wavebands, the detector element must be cooled (to about 80 K for the 8 to 14 μm band, and to about 200 K for the 3 to 5 μm band).
The envelope construction depends on the cooling method, which can be: thermo-electric, Joule-Thomson, or by means of a closed-cycle cooling engine (utilizing the Stirling cycle for example).

Thermo-electric coolers are normally used for temperatures down to 195 K. Two, three or four-stage coolers may be used, depending upon the operating temperature required, and upon the electrical cooling power allowed.

For temperatures down to 80 K, either Joule-Thomson coolers (usually working with air of high purity), or Stirling engines may be used. Joule-Thomson coolers can either be supplied with the detector, or purchased separately. Those detectors described in this documentation for engine cooling are designed for use with the Philips UA7011 engine. Thermo-electrically cooled detectors are provided with an integral cooler.

The dewars themselves can accommodate up to 120 elements, depending on the design; and the detector elements may be arranged in different configurations depending on application and on dewar design.

Infrared detectors described in the following data sheets use some of the terminology given below.

RESPONSIVITY

The purpose of an infrared detector is to convert infrared radiation into an electrical signal. The basic property defining detector performance is therefore its *responsivity*, defined as the r.m.s. output voltage produced by the detector per watt r.m.s. chopped radiant power incident on its sensitive area. It is important to distinguish between *peak responsivity* – the responsivity for monochromatic radiation at the wavelength of peak sensitivity, and *black-body responsivity* – the responsivity for black-body radiation from a source at a specified temperature (usually 500 K). In the latter case of course, some of the incident radiation will lie at wavelengths to which the detector is insensitive, but nevertheless, the total incident power is counted when calculating the responsivity. Black-body responsivity therefore will always be less than the peak responsivity. Responsivity is usually measured with a modulation frequency of 800 Hz.

NOISE

The electrical noise of a detector sets a limit on the lowest radiation level that can be detected. The noise is the r.m.s. value of the electrical output and is normally defined for 1 Hz bandwidth at a specific frequency.

NER (Noise Equivalent Resistance)

An alternative definition of the noise value is the Noise Equivalent Resistance (NER). This is the resistance which, at 20 °C, would have Johnson noise equal to that of the detector.

NEP (Noise Equivalent Power)

Detectors intended for measuring low intensity radiation may be assessed on the basis of their signal-to-noise ratio. This ratio depends on a number of test conditions: wavelength of the radiant energy incident on the detector, modulation frequency of the energy and of the noise, the energy incident, and bandwidth.

A more useful quantity for assessing detector performance is the noise equivalent power or N.E.P. This is the energy that will give a signal equal to the noise in a bandwidth of 1 Hz. It is, in general, a function of wavelength and of measuring frequency, and is equal to the noise per unit bandwidth divided by the responsivity. Note: N.E.P. may be either black-body or spectral, depending upon the reference source.

D* (D-star; AREA-NORMALIZED DETECTIVITY)

This is a figure of merit that takes account of element size and signal-to-noise ratio; it is defined by the expression:

$$D^* = \frac{\sqrt{A}}{NEP} = \frac{\text{responsivity} \times \sqrt{A}}{\text{noise}/\sqrt{\Delta f}}$$

in which A is the detector area.

This quantity is based on the fact that the NEP – for a certain type of detector at a certain temperature – is normally proportional to $\sqrt{A}$. Thus D* is normally independent of the area.

For an ideal detector, in which the noise is due only to fluctuations in the background radiation, the value of D* can be calculated (for a detector of given cut-off). This quantity is known as D^*_{BLIP}.

Thus, the use of D* enables comparison of detector performance with the maximum possible performance.

Both D^*_{BLIP} and the values obtained for D* on detectors at around 80 K are a function of the field of view, controlled by a cooled aperture in the detector.

D* is a function of the wavelength or black-body temperature of the incident radiation. The figures in brackets that follow D* refer to the measuring conditions. So D* (T,f,1) denotes normalized detectivity for incident radiation at a black-body temperature T (usually 500 K), noise measurement frequency f Hz, and unity bandwidth; and D* (λ,f,1) – sometimes called 'spectral D*' – denotes normalized detectivity for incident radiation at a wavelength λ.

TIME CONSTANT

The time constant τ of a detector is the time for the output to fall to 1/e (37%) of its value after a radiation pulse has ceased. It is related to the modulation frequency at which the responsivity falls to half of its low frequency value by $f = 1/2\pi\tau$.

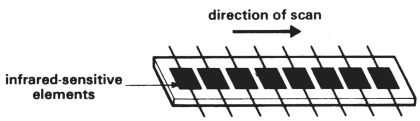
THE SPRITE* CONCEPT

An easy way of understanding the basic principles of the SPRITE detector is to compare it with the conventional in-line array of infrared-sensitive elements.

The old and new types of detector serve fundamentally the same purpose in converting thermal radiation from a scene into electrical signals, but there is a considerable difference in their complexity and their associated systems hardware.

THE CONVENTIONAL IN-LINE ARRAY

An in-line array comprises a row of separate elements of infrared-sensitive material on a sapphire substrate. Each element is provided with two electrical connections.



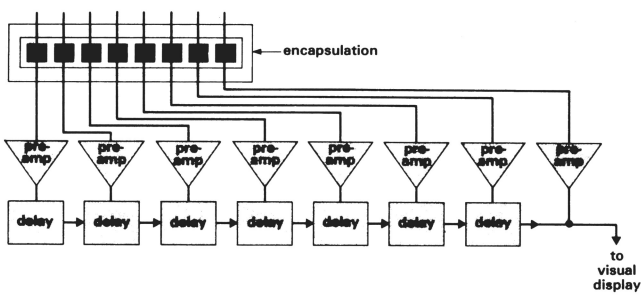
In a typical application, the infrared image is scanned along the length of the detector.

During the scan, the signal from each infrared-sensitive element is preamplified, delayed and then added to the signal which is generated in the following element.

In this way the signal for each picture point is 'built up' until the scan reaches the last element in the row. The sum of the separate signals is thus made available for amplification and visual display.

The preamplification, delay and summation circuitry (also called TDI for time delay and integration) is external to the detector. Therefore connections from the individual elements have to be brought out of the detector encapsulation.

Conventional in-line detectors need multiple-lead encapsulation and preamplification, time delay and summation circuitry.

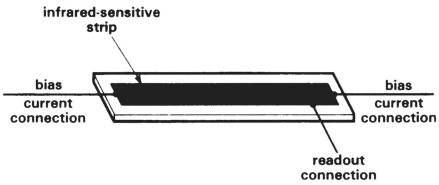


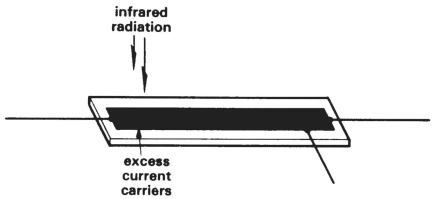
* The device described was developed at Mullard, Southampton, with support from the U.K. Ministry of Defence (Procurement Executive) sponsored by DCVD.
The SPRITE design is based on an idea from Royal Signals Research Establishment, Malvern, U.K.
For detailed information reference is made to the IEE conference proceedings on advanced IR-detectors and systems, Conf. Pub. no. 204, October 1981.

THE SPRITE DETECTOR

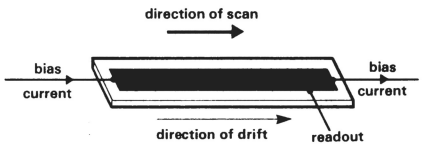
The SPRITE detector is essentially a strip of infrared-sensitive material on a sapphire substrate. There are only three electrical connections.

If a small region of the strip is exposed to infrared radiation, excess current carriers are generated in that region



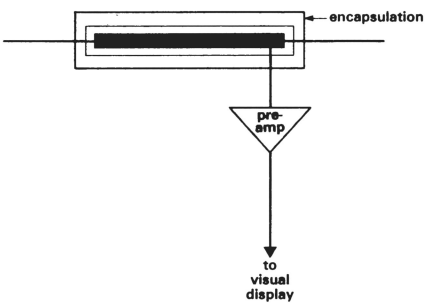


The excess current carriers 'drift' towards the readout region at a velocity which is determined by the magnitude of the bias current. The drift velocity is, in fact, quite high and is matched to the velocity at which the infrared image is scanned along the strip.



Consequently, the excess carriers are swept along the strip together with the infrared image, and all of the accumulated carriers arrive at the readout region at the same time. There is no need for time delay and summation circuitry, and only one readout connection is required. Thus, the improvement in signal-to-noise ratio obtained by summation is effected within the detector element itself.

SPRITE detector dramatically reduces the number of leads from the encapsulation, and completely dispenses with time delay and summation circuitry.



SPRITE DETECTORS

A series of infrared detectors comprising a number of cadmium-memory telluride (CMT) strip elements sensitive in the 8 to 13 μm or 3 to 5 μm region. The elements can be mounted in various encapsulations. These detectors are for high performance serial-parallel scan, thermal imaging applications.

TENTATIVE DATA

Elements

A typical configuration is shown in Fig. 1.

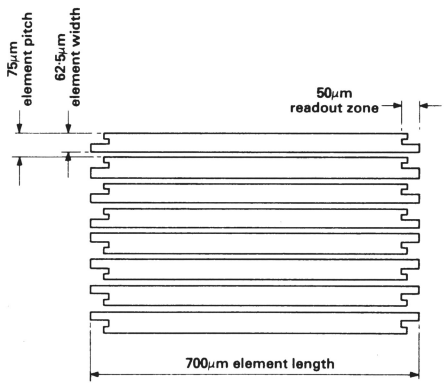


Fig. 1 Array configuration and dimensions.

Parameters for 8 to 13 μm SPRITE		
Nominal sensitive area		62,5 x 62,5 μm
Cut-off wavelength	typ.	10 to 13 μm
Resistance per element		200 to 800 Ω
Bias field for operation at 1,8 x 10^6 pixel/s		3 V/mm
Operating temperature		82 K
Cold shield field of view		f/2,2

Performance

The performance is strongly dependent on the bias field and field of view. Performances are quoted for a bias field of 3 V/mm, which corresponds to a pixel rate per element of $1{,}8 \times 10^6$ pixels per second and an effective cold shield equivalent to a circular aperture f/2,2.

Because of the absence of common leads in SPRITE arrays, there is no electrical crosstalk, unless pre-amplifiers mix signals.

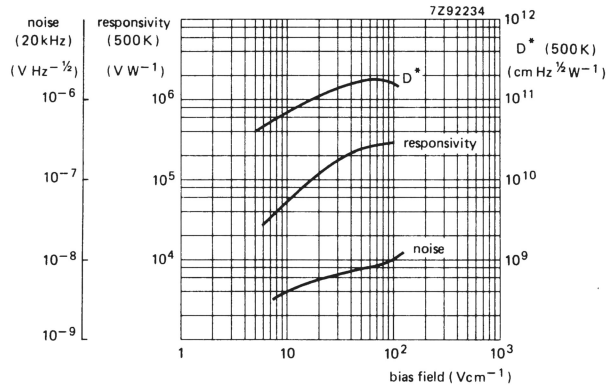


Fig. 2 Typical detector element performance with bias field.

Encapsulations

1800: 3 to 5 μm operation, with different parameters. For dimensions see page 68.

M1: 3 to 5 μm operation, with different parameters. For dimensions see page 72.

M2: 8 to 13 μm operation, Dewar vessel suitable for Joule-Thomson minicooler of 7,23 or 5,18 mm diameter. The encapsulation has an anti-reflection coated window. Two temperature sensors are mounted on the array substrate. For dimensions see page 76.

M3: 8 to 13 μm operation, Dewar vessel designed for use with UA7011 cooling engine. Two temperature sensors are mounted on the array substrate and a re-fireable getter is fitted. For dimensions see page 80.

GENERAL SAFETY RECOMMENDATIONS FOR INFRARED DETECTORS

1. GENERAL

When properly used and handled, infrared detectors do not constitute a risk to health or environment. Modern high technology materials have been used in the manufacture of these devices to ensure optimum performance. Some of these materials are toxic in certain circumstances. Mechanical or electrical damage is unlikely to give rise to any hazard, but toxic vapours may be generated if the devices are heated to destruction and it is important that the following recommendations are observed.

Care should be taken to ensure that all personnel who may handle, use or dispose of these products are aware of the necessary precautions.

Individual product data sheets will indicate whether any specific hazards are likely to be present.

2. DISPOSAL

These devices should be disposed of in accordance with the relevant legislation.

3. FIRE

Infrared detectors themselves, when used within the specified limits, do not present a fire hazard.

Devices can contain arsenic, beryllium, cadmium, lead, mercury, selenium, tellurium or similar hazardous materials or compounds, which, if exposed to high temperatures may emit toxic or noxious fumes.

Most packaging materials are flammable and care should be taken in the disposal of such materials, some of which will emit toxic fumes if burned.

4. HANDLING

Care must be exercised with those devices incorporating glass or plastic. If these devices are broken, precautions must be taken against the following hazards that may arise:

Broken glass or ceramic. Protective clothing such as gloves should be worn.
Contamination from toxic materials and vapours. In particular, skin contact and inhalation must be avoided.

5. BERYLLIUM COMPOUNDS

Beryllium oxide dust is toxic if inhaled or if particles enter a cut or an abrasion. At all times avoid handling beryllium oxide ceramics; if they are touched, the hands must be washed thoroughly with soap and water. Do nothing to beryllium oxide ceramics that may produce dust or fumes.

Care should be taken upon eventual disposal that they are not thrown out with general industrial waste. Users seeking disposal of devices incorporating beryllium oxide ceramics should first take advice from the manufacturer's service department.
This potential hazard is present at all times from receipt to disposal of devices.

6. CADMIUM COMPOUNDS

Cadmium compounds are toxic. In the event of accidental breakage, cadmium compound dust may be released. Gloves should be worn and the dust should be mopped up with a damp cloth. Upon disposal, the cloth should be sealed in a plastic bag and the hands washed thoroughly with soap and water. Controlled disposal of devices containing cadmium compounds should be conducted in the open air or in a well ventilated area.
Inhalation of cadmium dust must be avoided.
This potential hazard is present, if breakage occurs, at all times from receipt to disposal of devices.

7. OTHER COMPOUNDS

Other compounds, such as those containing arsenic, indium, lead, lithium, selenium, tantalum, tellurium etc., may be toxic by ingestion or inhalation.

The above information and recommendations are given in good faith and are in accordance with the best knowledge and opinion available at the date of the compilation of the data sheets.

SURVEY OF TYPES

Infrared detectors

types	spectral band μm	operating temp. K	cooling method	number of elements	half angle deg.	page
1800	3 to 5	205	thermo-electric	–		68
H1812	3 to 5	205	thermo-electric	12	⩾ 30	70
T1813	3 to 5	205	thermo-electric	8 el. SPRITE	⩾ 30	71
M1RPY	3 to 5	195	thermo-electric	–		72
M113RPY	3 to 5	195	thermo-electric	48	⩾ 30	74
M2RPY	8 to 13	80	Joule-Thomson	–		76
T1527	8 to 13	80	Joule-Thomson	8, SPRITE	⩾ 13	78
K1733	8 to 13	80	Joule-Thomson	32	⩾ 14	79
M3RPY	8 to 13	80	Stirling engine	–		80
M4RPY	3,8 to 5,6	220	thermo-electric	–		83
M401RPY	3,8 to 5,6	220	thermo-electric	1	50	85

Other types concerning

- encapsulation
- cooling method
- elements, either conventional or SPRITE

may be available on request.

INFRARED DETECTORS

A series of thermoelectric cooled infrared detectors comprising either an array of up to 24 conventional elements in a series of different configurations or an array of up to 8 SPRITE elements, sensitive in the 3,8 to 5,6 μm region. The sensitive material is cadmium-mercury-telluride (CMT). Mounted in a small, rugged 38-lead encapsulation including a three-stage thermoelectric cooler, stability and long life is expected from the low thermal conductivity gas filling of the device. A temperature sensor enabling the array temperature to be monitored and controlled if desired is built in each detector.

The devices are particularly suitable for use in handheld thermal imaging systems.

QUICK REFERENCE DATA

Material	Cd Hg Te
Operating temperature	205 K
Sensitive wavelength	3,8 to 5,6 μm
Cooling	3-stage thermoelectric cooler
Number of elements	
conventional	max. 24
SPRITE	max. 8

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes	
Temperature sensing diode current	10 mA
Cooler bias current	1,3 mA
Element bias current will depend on element dimensions	
Total element bias power	25 mW
Storage temperature	−50 to +70 °C

TYPICAL PERFORMANCE DATA

		discrete elements	SPRITE elements	
Number of elements	max.	24	8	
Element dimensions		50 x 50	700 x 62,5	nm
Operating temperature	nom.	205	205	K
Heatsink temperature		20 ± 2	20 ± 2	°C
Cooler input power		3	3	W
Cool-down time		30	30	s
Element bias		0,5		mA
D* (500 K, 20 kHz, 1)		1×10^{10}	4×10^{10}	$cmHz^{½}W^{-1}$
average	min.	$0,7 \times 10^{10}$	$2,8 \times 10^{10}$	$cmHz^{½}W^{-1}$
any element	min.	$0,5 \times 10^{10}$	2×10^{10}	$cmHz^{½}W^{-1}$
D* (λ_{pk}, 20 kHz, 1)		1×10^{11}	4×10^{11}	$cmHz^{½}W^{-1}$
Responsivity (500 K, 800 Hz)		1×10^{4}	$1,3 \times 10^{5}$	VW^{-1}
Cut-off wavelength		5,2 ± 0,2	5,2 ± 0,2	μm
Resistance		300	2000	Ω
Time-constant		2	n. appl.	μs
Knee frequency		2	2	kHz

CUSTOMIZED DESIGNS

The encapsulation is standard but special combinations of element size, number of elements, array configuration and cut-off wavelength can be considered.

CAUTION

The devices are entirely safe provided that they are not dismantled.

Care should be taken to ensure that all those who may handle, use, or dispose of these devices are aware of their nature and of the necessary safety precautions. In particular, they should never be thrown out with general industrial or domestic waste. Devices requiring disposal can be returned to the suppliers. Please consult us before returning any devices.

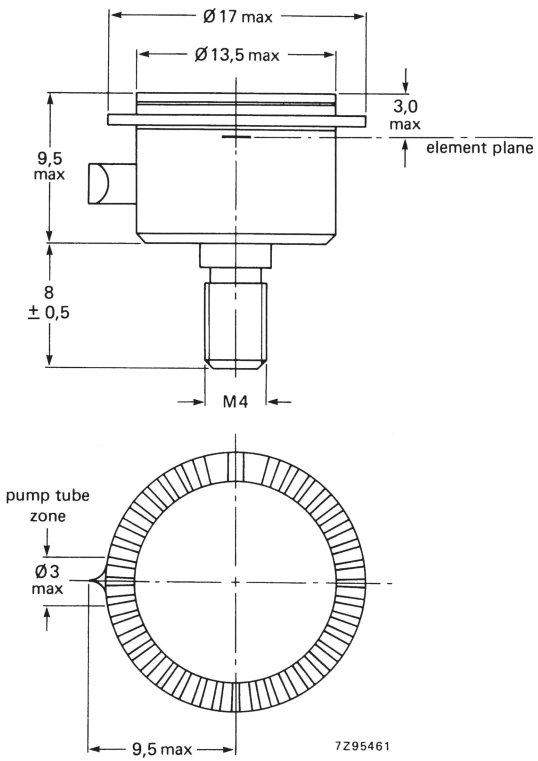


Fig. 1 Outline of 1800 - Series infrared detectors.

INFRARED DETECTOR

This infrared detector conforms to the specifications of the 1800 series and compromises a linear array of 12 conventional elements. For this reason only changes or additions, relevant to H1812 are given in this data sheet.

QUICK REFERENCE DATA

Number of elements	12
Element size	50 x 50 μm
Spacing between element centres	62,5 μm
Array configuration	linear
Field of view (½ angle)	$\geqslant$ 30 deg

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Cooler bias current	1,3 A
Element bias current	3 mA
Temperature sensing diode bias current	10 mA

PERFORMANCE DATA

Typical performance data is given below. Measurements were made with the drive current to the thermo-electric cooler optimized to give the lowest possible detector temperature; this current is typically 1 A at 3 V.

Heatsink temperature	20 ± 2 °C
Cooler input power	3 W
Cool-down time	30 s
Element bias current	0,5 mA
D* (500 K, 20 Hz, 1)	$1{,}0 \times 10^{10}$ cmHz^{½}W^{-1}
D* (λ_{pk}, 20 Hz, 1)	$5{,}5 \times 10^{10}$ cmHz^{½}W^{-1}
Responsivity (500 K, 800 Hz)	$1{,}0 \times 10^{3}$ VW^{-1}
Cut-off wavelength	5,2 ± 0,2 μm
Resistance	200 to 500 Ω
Time constant	2 μs
Knee frequency	2 kHz

INFRARED DETECTOR

This infrared detector conforms to the specifications of the 1800 series and compromises an 8-element SPRITE configuration. For this reason only changes or additions, relevant to T1813 are given in this data sheet. See also general data on SPRITE.

QUICK REFERENCE DATA

Number of SPRITE elements	8
Element size	62,5 x 700 μm
Spacing between element centres	75 μm
Nominal read-out area	62,5 x 62,5 μm
Field of view (½ angle)	$\geqslant$ 30 deg

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Cooler bias current	1,3 A
Element bias current	10 mA
Temperature sensing diode bias current	10 mA

PERFORMANCE DATA

Typical performance data is given below, with eight detectors biased at 4 V/mm. This corresponds with a pixel rate per element of nominal 0,8 x 10^6 pixel/s.

D* (500 K, 20 kHz, 1; 62,5 x 62,5 μm)	4,0 x 10^{10} cmHz^{½}W^{-1}
Responsivity (500 K, 800 Hz)	1,3 x 10^5 VW^{-1}
Cut-off wavelength	5,2 $\pm$ 0,2 μm
Resistance	2 kΩ

INFRARED DETECTORS

A series of thermoelectric cooled infrared detectors comprising either an array of up to 64 conventional elements in a series of different configurations or an array of up to 20 SPRITE elements, sensitive in the 3 to 5 μm region. Mounted in a small rugged 80-lead encapsulation with a sapphire window. The sensitive material is cadmium-mercury-telluride (CMT). The devices are particularly suitable for use in hand held thermal imaging systems. A temperature sensor is built in each detector. Vacuum and back-filled encapsulations are available.

QUICK REFERENCE DATA

Material	Cd Hg Te
Operating temperature	195 K
Sensitive wavelength	3 to 5 μm
Cooling	3 to 4-stage thermoelectric cooler
Number of elements	
conventional	max. 64
SPRITE	max. 20

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Temperature sensing diode current	10 mA
Storage temperature:	
vacuum encapsulation	−50 to +50 °C
backfilled encapsulation	−50 to +70 °C

TYPICAL VALUES

Element bias current	
conventional	3 mA
SPRITE, bias terminals	3 mA
SPRITE, output terminals	0,5 mA

ENCAPSULATIONS

Two standard encapsulations are available. The R124 is a vacuum device with getter and uses a 4-stage 3 or 6 W cooler. The outlines are shown in Fig. 1. The R132 is backfilled with low thermal conductivity gas and similar in size except that the getter and pump tube are not present. It uses a 3-stage 3 W cooler.

CUSTOMIZED DESIGNS

The above two encapsulations are standard. Special combinations of element size, number of elements, array configuration and cut-off wavelength are possible. Also other types of encapsulation and/or cooler may be available to suit specific requirements.

CAUTION

These devices may incorporate beryllium oxide, the dust of which is toxic. The devices are entirely safe provided that they are not dismantled.

Care should be taken to ensure that all those who may handle, use, or dispose of these devices are aware of their nature and of the necessary safety precautions. In particular, they should never be thrown out with general industrial or domestic waste. Devices requiring disposal can be returned to the suppliers. Please consult us before returning any devices.

Dimensions in mm

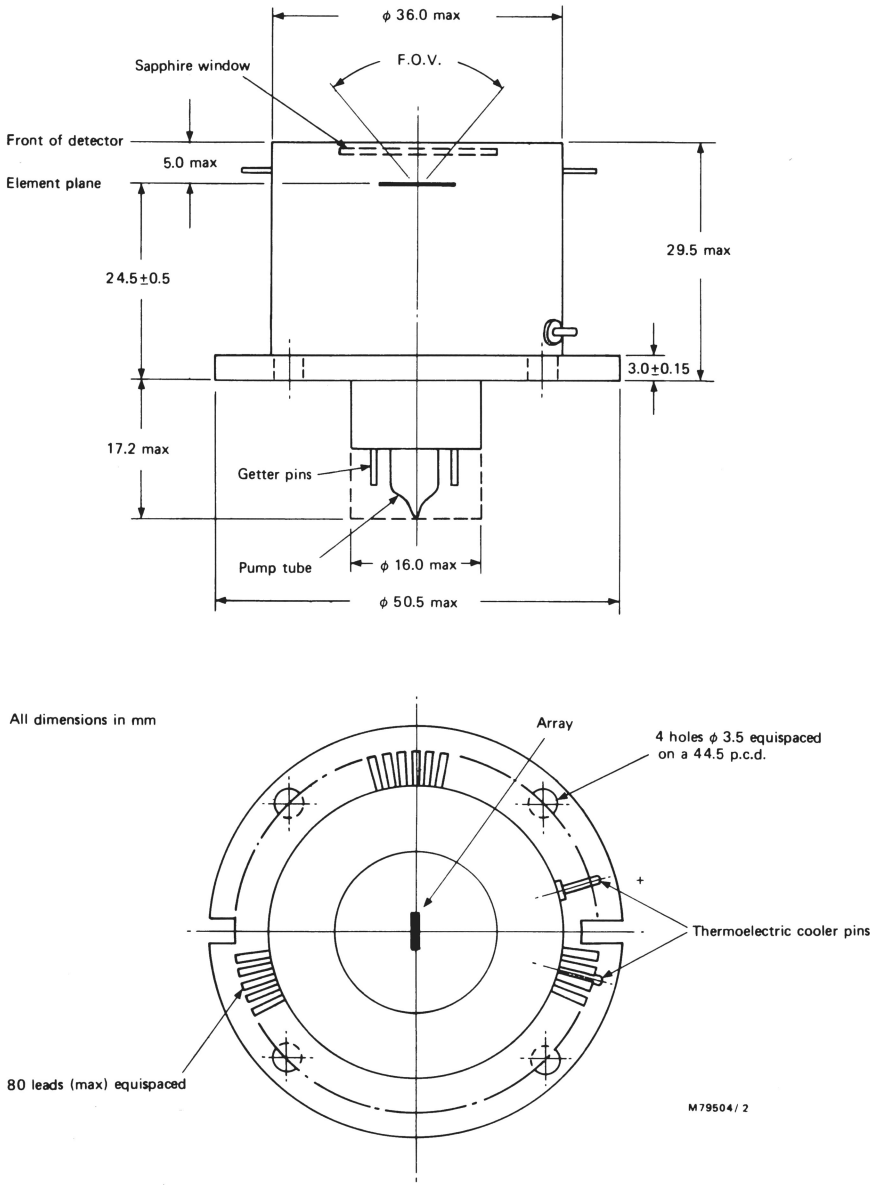


Fig. 1 Outline of R124 encapsulation.

INFRARED DETECTOR

This infrared detector conforms to the specifications of the M1RPY series and comprises a linear array configuration in an R124 encapsulation. For this reason only changes or additions, relevant to M113RPY are given in this data sheet.

QUICK REFERENCE DATA

Number of elements	48	
Element size	50 x 50	μm
Spacing between element centres	62,5	μm
Array configuration	linear	
Field of view (½ angle)	⩾ 30	deg

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Cooler bias current	0,6	A
Element bias current	3	mA
Temperature sensing diode bias current	10	mA
Storage temperature	−50 to +50	°C

Mechanical and performance data

Typical performance data is given below. Measurements were made with the drive current to the thermo-electric cooler optimized to give the lowest possible detector temperature; this current is typically 0,55 A.

Heatsink temperature	20 ± 2	°C
Cooler input power	3	W
Cool-down time	30	s
Element bias current	0,7	mA
D* (500 K, 20 kHz, 1)	$1{,}5 \times 10^{10}$	$cmHz^{½}W^{-1}$
D* (λ_{pk}, 20 kHz, 1)	$1{,}1 \times 10^{11}$	$cmHz^{½}W^{-1}$
Responsivity (500 K, 800 Hz)	$1{,}2 \times 10^{4}$	VW^{-1}
Cut-off wavelength	4,8 ± 0,2	μm
Resistance	300	Ω
Time-constant	2	μs
Knee frequency	2	kHz
Noise equivalent resistance	1	kΩ

Area normalized detectivity D*

Area normalized detectivity for a typical M113RPY detector is plotted against frequency in Fig. 1.

Noise

A typical noise spectrum for a M113RPY detector is shown in Fig. 1.

Responsitivity

Responsitivity as a function of frequency is shown in Fig. 1.

OPERATION

A connection diagram is supplied with every device. Care should be taken to ensure that the cooler supply is connected with the correct polarity. The input voltage to the cooler should be d.c. with less than 10% peak-to-peak ripple. As stated earlier, typical optimum current for detector operation at 195 K is 0,55 A.

The detectors should be mounted on a flat heatsink. Use of a thermally-conducting heatsink compound is recommended; a suitable paste is Dow Corning 340. Responsivity and D* as a function of heatsink temperature are shown in Fig. 2.

A temperature-sensing diode is mounted with the detector array in the encapsulation. To measure the element temperature, this diode should be forward-biased with a constant current of 1 mA and the resulting voltage monitored. A calibration curve showing diode voltage as a function of element temperature is supplied with each device. Again, care should be taken to ensure that the diode supply is correctly connected.

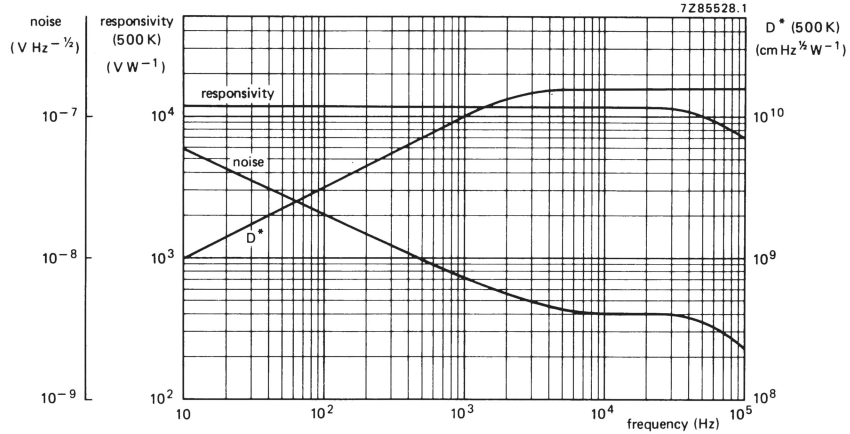


Fig. 1 Typical D* (500 K), noise, and responsivity plotted against frequency.

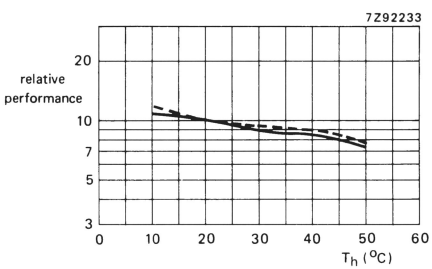


Fig. 2 D* (500 K) and responsivity plotted against heatsink temperature.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

INFRARED DETECTORS

A series of infrared detectors comprising either an array of up to 48 conventional elements or an array of up to eight SPRITE elements, sensitive in the 8 to 13 μm region. Mounted in dewar vessels for Joule-Thomson cooling. The window is anti-reflection coated germanium. The encapsulation contains a cooled radiation shield to match the optical system and a temperature sensor.

QUICK REFERENCE DATA

Material	Cd Hg Te
Operating temperature	80 K
Sensitive wavelength	8 to 13 μm
Cooling method	Joule-Thomson
Number of elements	
conventional	max. 48
SPRITE	max. 8

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Temperature sensing diode bias current	10 mA
Storage temperature	−55 to +70 °C

ENCAPSULATION

The outline of the M2RPY encapsulation is shown in Fig. 1. This is suitable for a 7,23 mm diameter cooler. The encapsulation includes a temperature-sensing diode which enables the array temperature to be monitored.

Similar encapsulations to suit 5,18 mm diameter coolers are available.

CUSTOMIZED DESIGNS

The encapsulations are standard, but special combinations of element size, number of elements and array configuration can be considered.

CAUTION

The devices are entirely safe provided that they are not dismantled.

Care should be taken to ensure that all those who may handle, use, or dispose of these devices are aware of their nature and of the necessary safety precautions. In particular, they should never be thrown out with general industrial or domestic waste. Devices requiring disposal can be returned to the suppliers. Please consult us before returning any devices.

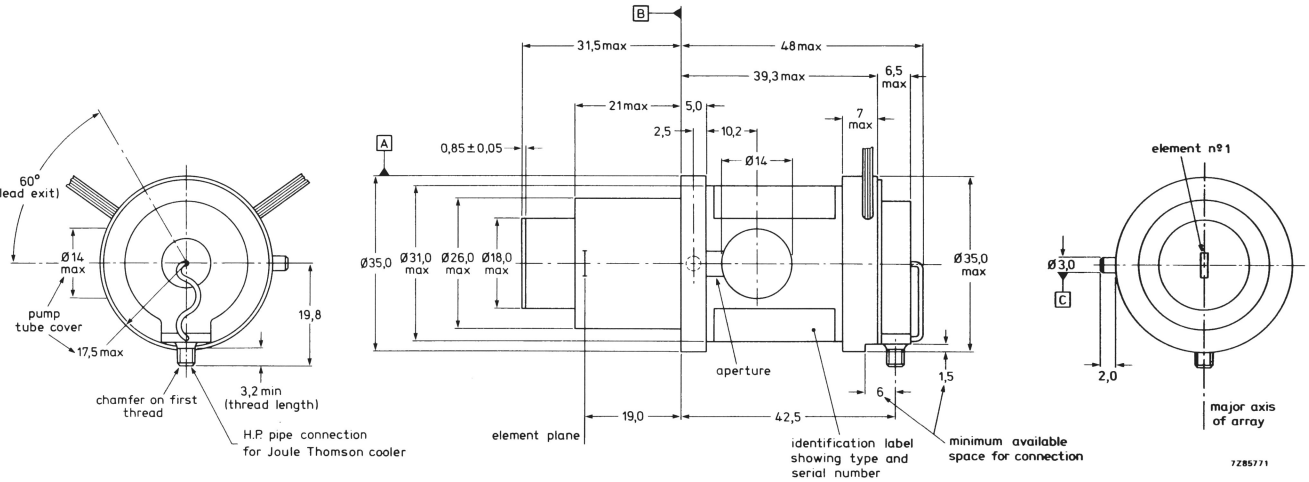


Fig. 1 Outline of M2RPY encapsulation.

DEVELOPMENT DATA

This data sheet contains advance information and specifications are subject to change without notice.

INFRARED DETECTOR

This infrared detector conforms to the specifications of the M2RPY series and comprises an 8-element SPRITE configuration. For this reason only changes or additions, relevant to T1502 are given in this data data sheet. See also general data on SPRITE.

QUICK REFERENCE DATA

Number of SPRITE elements	8	
Element size	62,5 x 700	μm
Spacing between element centres	75	μm
Nominal read-out area	62,5 x 62,5	μm
Field of view (½ angle)	⩾ 13	deg

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Element bias current	10	mA
Temperature sensing diode bias current	10	mA
Storage temperature	−50 to +50	°C

PERFORMANCE DATA

Typical performance data is given below, with eight detectors biased at 3 V/mm. This corresponds with a pixel rate per element of nominal $1{,}8 \times 10^6$ pixel/s.

D* (500 K, 20 kHz, 1; 62,5 x 62,5 μm	$7{,}5 \times 10^{10}$	$cmHz^{½}W^{-1}$
Responsivity (500 K, 800 Hz)	$2{,}5 \times 10^5$	VW^{-1}
Cut-off wavelength	10,3 to 12,5	μm
Resistance	450	Ω

INFRARED DETECTOR

This infrared detector conforms to the specifications of the M2RPY series and contains a linear array of 50 μm square elements. Only changes or additions, relevant to K1733 are given in this data sheet.

QUICK REFERENCE DATA

Number of elements	32	
Element size	50 x 50	μm
Spacing between element centres	62,5	μm
Field of view (½ angle)	$\geqslant$ 14	deg

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Element bias current	7	mA
Temperature sensing diode bias current	10	mA
Storage temperature	−55 to + 70	°C

PERFORMANCE DATA (typical)

Bias current	3	mA
D* (500 K, 20 kHz, 1)	$2{,}5 \times 10^{10}$	$cmHz^{½}W^{-1}$
Responsivity (500 K, 800 Hz)	$1{,}6 \times 10^{4}$	VW^{-1}
Resistance	45	Ω
Cut-off wavelength	11 to 13	μm

INFRARED DETECTORS

A series of infrared detectors comprising a multi-element array, in a series of different configurations, sensitive in the 8 to 13 μm region and mounted in a glass and metal dewar-type envelope. The sensitive material is cadmium-mercury-telluride (CMT). Both conventional and SPRITE elements can be supplied. The detectors are designed to be cooled by the Philips UA7011 closed-cycle cooling engine. A temperature monitoring facility is built into the detector. These detectors have been developed to meet the requirements of military thermal imaging systems.

QUICK REFERENCE DATA

Material	Cd Hg Te
Operating temperature	80 K
Sensitive wavelength	8 to 13 μm
Cooling engine	UA7011
Terminations	3 ITT cannon plugs MDM21PL1B embodied in encapsulation
Number of elements	
conventional	max. 55
SPRITE	max. 8

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Temperature sensing diode bias current	10 mA
Storage temperature, on shelf in special container or in system	−55 to +70 °C
Operating ambient temperature	−40 to +70 °C
Over-pressure in dewar re-entrant	$2{,}5 \times 10^5$ Pa

ENCAPSULATION

The outline of the M3RPY encapsulation is shown in Fig. 1. The encapsulation includes a temperature-sensing diode which enables the array temperature to be monitored.

A re-fireable getter may also be fitted in the encapsulation to help sustain long vacuum life. Reactivation is required at 12 months operation; the current and voltage required is about 3,5 A at 5 V.

CUSTOMIZED DESIGNS

The encapsulation is standard, but special combinations of element size, number of elements, array configuration (conventional) can be considered.

PACKAGING

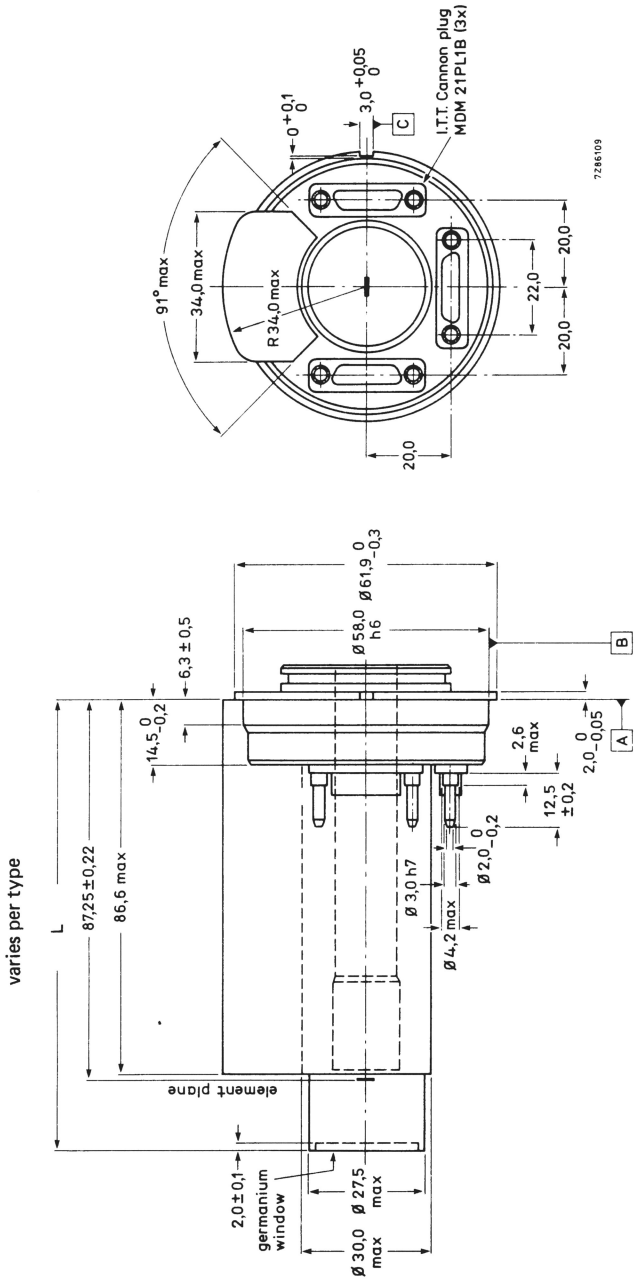
The detectors are supplied in a reusable sealed package filled with a He-free gas, at a slight over-pressure.

Packing/unpacking instructions, getter reactivation instructions and getter reactivation leads are supplied with each detector. The detector is fitted with a protective window cap and connector caps.

PRODUCT SAFETY

Risks from implosion/explosion

The product is designed and constructed to be safe and without risk when properly used. However, it is evacuated, giving a risk to personnel if incorrectly used or handled. In particular, a risk exists from possible explosion, when combined with a cooling engine, if the engine finger/detector bore volume is not fitted with a blow-off valve or other over-pressure safety device to guard against sealing failures.



Notes

1. A, B and C are reference planes.
2. Tolerances and details are available upon request.
3. This detector is designed to interface with Philips Stirling cooling engine UA7011.

INFRARED DETECTORS

A series of single-element cadmium-mercury-telluride (CMT) infrared detectors, sensitive in the 3 to 5 μm region. They are mounted in a rugged sapphire-windowed encapsulation, incorporating a thermoelectric cooler and a temperature sensing diode.

The applications are in industrial and military equipment.

QUICK REFERENCE DATA

Material	Cd Hg Te
Number of elements	1
Element size	0,05 mm square to 1,25 mm square
Sensitive wavelength	3 to 5 μm
Operating temperature	220 K
Cooling method	thermoelectric, two-stage cooler

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Temperature sensing diode bias current	10 mA
Storage temperature	−55 to +70 °C

ENCAPSULATION

The outline of the M4RPY encapsulation is shown in Fig. 1. Care should be taken to ensure that the cooler supply is connected with the correct polarity. The input voltage to the cooler should be d.c. with less than 10% peak-to-peak ripple.

The detectors are normally operated on a heatsink. When mounting, use of a thermally-conducting compound is recommended. The temperature-sensing diode is the emitter-base junction of a BC107 transistor, mounted with the element in the encapsulation. To measure the element temperature, this diode is supplied with a constant current of 1 mA and the resulting voltage monitored. Care should be taken to ensure that the diode supply is connected correctly.

TYPES

The range of available elements is as follows:

0,05 x 0,05 mm	0,23 x 0,23 mm
0,075 x 0,075 mm	0,30 x 0,30 mm
0,125 x 0,125 mm	1,25 x 1,25 mm.

CUSTOMIZED DESIGNS

Any combination of element size and cut-off wavelength can be considered.

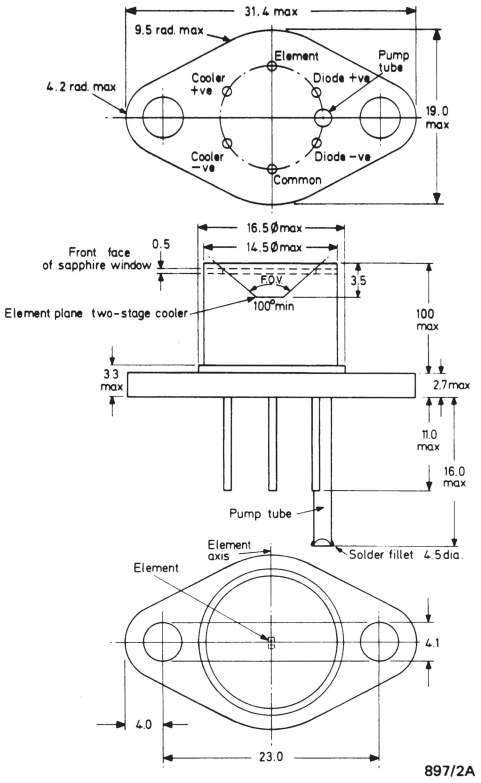


Fig. 1 Outline and pin functions.

INFRARED DETECTORS

This infrared detector conforms to the specifications of the M4RPY series and comprises a 230 μm square element. For this reason only changes or additions, relevant to M401RPY are given in this data sheet.

QUICK REFERENCE DATA

Number of elements	1	
Element size	230 x 230	μm
Cut-off wavelength	4,8	μm
Field of view (½ angle)	$\geqslant$ 50	deg

LIMITING VALUES

Absolute maximum rating system, not for inspection purposes

Cooler bias current	1,2	A
Element bias current	2	mA
Temperature sensing diode bias current	10	mA

PERFORMANCE DATA

Based on a two-stage cooled detector

Heatsink temperature	20 ± 5	°C
Cooler input power	1,5	W
Cool-down time	30	s
Element bias current	0,5	mA
D* (500 K, 20 kHz, 1)	5×10^9	$cmHz^{½}W^{-1}$
Responsivity (500 K, 800 Hz)	1×10^3	VW^{-1}
Resistance	200	Ω
Knee frequencies	1	kHz
Noise equivalent resistance	4,0	kΩ

Area normalized detectivity D*

Area normalized detectivity D* (500 K) for a typical detector (λ_{pk} = 4,8 μm) is plotted against frequency in Fig. 1.

Noise

A typical noise spectrum is shown in Fig. 1.

Responsivity

Responsivity as a function of frequency is shown in Fig. 1.

OPERATION

A connection diagram is supplied with every device. Care should be taken to ensure that the cooler supply is connected with the correct polarity. The input voltage to the cooler should be d.c. with less than 10% peak-to-peak ripple. As stated earlier, typical optimum current, for detector operation at 195 K is 0,55 A.

The detectors should be mounted on a flat heatsink. Use of a thermally-conducting heatsink compound is recommended; a suitable paste is Dow Corning 340. Responsivity and D* as a function of heatsink temperature are shown in Fig. 2.

A temperature-sensing diode is mounted with the detector array in the encapsulation. To measure the element temperature, this diode should be forward-biased with a constant current of 1 mA and the resulting voltage monitored. A caliberation curve showing diode voltage as a function of element temperature is supplied with each device. Again, care should be taken to ensure that the diode supply is correctly connected.

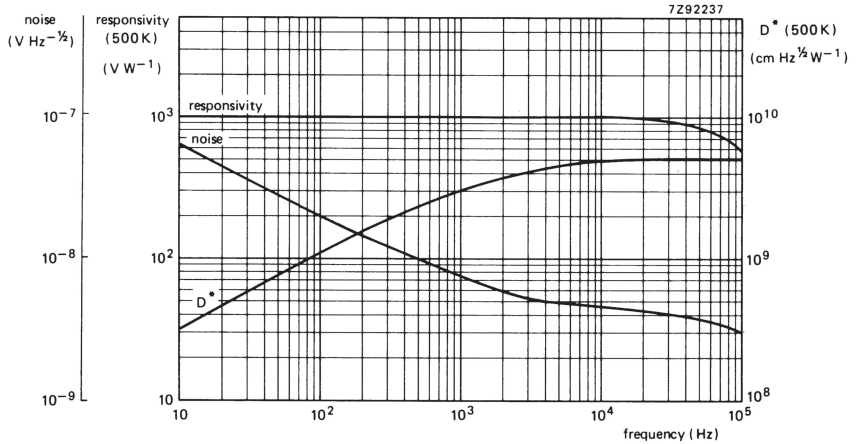


Fig. 1 Responsivity, D* (500 K), and noise plotted against frequency for a detector with λ_{pk} = 4,8 μm.

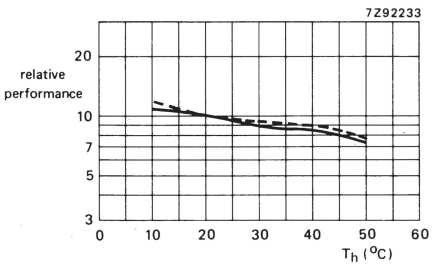


Fig. 2 D* (500 K) and responsivity plotted against heatsink temperature.

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